FISHERY RESEARCH

IDAHO ADULT CHINOOK SALMON MONITORING

2021 ANNUAL REPORT

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Idaho Adult Chinook Salmon Monitoring

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ABBREVIATIONS AND ACRONYMS

BIG	Big Creek
BPA	Bonneville Power Administration
BVC	Bear Valley Creek
BY	Brood Year
CAM	Camas Creek
CHC	Chamberlain Creek
CWT	Coded Wire Tag
DPS	Distinct Population Segment
EFSR	East Fork Salmon River
EFSFSR	East Fork South Fork Salmon River
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
FINS	Fish Inventory System Hatchery Database
GPS	Global Positioning System
ICBTRT	Interior Columbia Basin Technical Recovery Team
IFWIS	Idaho Fish and Wildlife Information System
IDFG	Idaho Department of Fish and Game
LAP	Lapwai/Big Canyon creeks
LEM	Lemhi River
LSR	Little Salmon River
LOC	Lochsa River
LOLO	Lolo Creek
LOON	Loon Creek
LNFC	Lower North Fork Clearwater River
MAR	Marsh Creek
MED	Meadow Creek
MPG	Major Population Group
MFSRU	Middle Fork Salmon River above and including Indian Creek
MFSRL	Middle Fork Salmon River below Indian Creek
MOO	Moose Creek
NFSR	North Fork Salmon River
NMFS	U.S. Department of Commerce, National Marine Fisheries Service

NOAA	National Oceanic and Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NPT	Nez Perce Tribe
NRAAL	Nampa Research Anadromous Ageing Laboratory
NWFSC	Northwest Fisheries Science Center
PA	Percent Agreement
PAH	Pahsimeroi River
PAN	Panther Creek
PCSRF	Pacific Coast Salmon Recovery Funds
PDO	Pacific Decadal Oscillation
PIT	Passive Integrated Transponder
POT	Potlatch River
PSMFC	Pacific States Marine Fisheries Commission
PTAGIS	PIT Tag Information System
RMSE	Root Mean Squared Error
SAR	Smolt-to-adult Return Rate
SBT	Shoshone-Bannock Tribes
SEC	Secesh River
SEL	Upper Selway River
SFSR	South Fork Salmon River mainstem
SGS	Spawning Ground Survey
SGSA	Spawning Ground Survey Application
SUL	Sulphur Creek
UAS	Unmanned Aircraft System
USFS	U.S. Forest Service
UNFC	Upper North Fork Clearwater River
USFC	Upper South Fork Clearwater River
USRL	Salmon River Lower Mainstem (below Redfish Lake Creek)
USRU	Salmon River Upper Mainstem (above Redfish Lake Creek)
VAL	Valley Creek
YFK	Yankee Fork Salmon River

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FOREWORD

INTRODUCTION

Historically, Idaho waters supported abundant, naturally reproducing Chinook Salmon *Oncorhynchus tshawytscha* runs, which represented an important cultural, economic, and recreational resource within the state (Fulton 1968; Chapman 1986). Adult spring-run, summer-run, and fall-run Chinook Salmon migrate through the Columbia River and enter Idaho via the Snake River. Fall-run Chinook Salmon are currently monitored in Idaho by Idaho Power Company and the Nez Perce Tribe. As such, this report is exclusively focused on spring-summer Chinook Salmon.

Snake River spring-summer Chinook Salmon runs were historically supported by populations that spawned in the Salmon River and Clearwater River basins of Idaho. The Salmon River basin has long been recognized as the most productive spawning area for spring-summer Chinook Salmon in the entire Columbia River basin (Fulton 1968). During the late 1950s, an estimated 44 percent of the spring and summer runs in the Columbia River, and 83 percent in the Snake River, were destined for the Salmon River basin (Fulton 1968). The Clearwater River basin represented an important spawning area for spring-summer Chinook Salmon until 1927, when the construction of Lewiston Dam prevented passage and functionally extirpated all populations in this basin (Fulton 1968). Lewiston Dam was removed in 1973 to accommodate other projects taking place as part of the Federal Columbia River Power System (FCRPS). The Clearwater Reintroduction Program was active from the early 1960s into the 1980s to restore salmon to the Clearwater River basin with some success, as measured by redd counts (e.g., Lindland and Bowler 1989). Dworshak Dam, located on the North Fork Clearwater River 5 km upstream of the confluence with the Clearwater River, was completed in 1973 and currently prevents spring-summer Chinook Salmon passage into previously productive spawning grounds (Fulton 1968). Hence, population abundance in the Salmon and Clearwater basins has declined from historic levels but their history and current status are quite different.

Populations of spring-summer Chinook Salmon in the Snake River basin declined substantially following the construction of hydroelectric dams in the Snake and Columbia rivers in the late 1960s and early 1970s. Survival of all Chinook Salmon runs emigrating from the Snake River basin decreased following the construction of these dams (Raymond 1988). Shifts in ocean climatic regime also contributed to an unfavorable state for all Columbia River salmonid stocks in the 1980s and early 1990s (Mantua et al. 1997). Declines in abundance from the late 1960s until the early 1990s resulted in listing of Snake River spring-summer Chinook Salmon as threatened under the Endangered Species Act (ESA) in 1992 (Federal Register notice 57FR14653). Abundance has been variable since the initial 1992 listing but observed increases have not been sufficient for delisting (NMFS 2016).

Current monitoring for Snake River spring-summer Chinook Salmon recovery is framed by population boundaries established by the Interior Columbia Basin Technical Recovery Team following ESA guidance (ICBTRT 2003, 2005; Figure 1). The ESA defines species to include subspecies and distinct population segments (DPS) of vertebrate species. Policy guiding identification of DPS for salmon species directs the National Marine Fisheries Service (NMFS) to identify population groups that are evolutionarily significant units (ESU) within their species (NMFS 2016). NMFS considers a group of populations an ESU “if it is substantially reproductively isolated from other populations, and represents an important component in the evolutionary legacy of the biological species” (NMFS 2016). Evolutionarily Significant Units are divided into hierarchical levels including Major Population Groups (MPGs), which are further divided into demographically independent populations (McElhany et al. 2000; ICBTRT 2005). The Snake River spring-summer Chinook Salmon ESU is organized into seven MPGs, five of which are in Idaho (ICBTRT 2005). A total of 33 independent populations have been identified in Idaho, of which 12 have been extirpated. However, 6 previously extirpated populations have been re-established in Clearwater MPGs with stocks from extant Snake River populations. The Panther Creek population in the Upper Salmon MPG was also extirpated and re-established. Currently there are 27 extant or re-established populations across all 5 Idaho MPGs.

Anadromous fish management programs in the Snake River basin include large-scale hatchery programs – intended to mitigate for the impacts of hydroelectric dam construction and operation in the basin – and recovery planning and implementation efforts aimed at recovering ESA-listed wild salmon and steelhead stocks. The Idaho Department of Fish and Game's anadromous fish program long-range goals, consistent with basinwide mitigation recovery programs, are to preserve Idaho's salmon and steelhead runs and recover them to provide benefit to all users (IDFG 2019). Management to achieve these goals requires an understanding of how salmon populations function (McElhany et al. 2000) as well as regular status assessments.

The Idaho Salmon and Steelhead Monitoring and Evaluation Studies are designed to collect information necessary to assess the status of Idaho's spring-summer Chinook Salmon (hereafter Chinook Salmon) populations relative to IDFG and ESA goals. These data are used in fishery planning and management in accordance with goals for wild- and natural-origin Chinook Salmon stated in the current IDFG fisheries management plan (IDFG 2019). Additionally, status of Pacific salmonids listed under the ESA is assessed by NMFS using viability criteria which are related to trends and status in abundance, productivity, spatial structure, and diversity (McElhany et al. 2000). Data collected from this project were provided to NMFS for status review of extant MPGs of the Snake River spring-summer Chinook Salmon ESU (Ford 2022).

Natural-origin fish were those produced outside of a hatchery, whereas hatchery-origin fish were those produced in a hatchery. For the purposes of this report, wild-origin fish, as determined by genetic lineage (IDFG 2019), were considered to be a subset of natural-origin fish. Hatchery fish were further distinguished by either segregated or integrated production type. Segregated hatchery-origin Chinook Salmon were those produced from crosses of hatchery fish only, whereas integrated hatchery-origin fish were produced from crosses of either two natural-origin parents or crosses of one natural- and one hatchery-origin parent. Carcasses with an adipose fin clip were considered segregated hatchery-origin. Carcasses with an intact adipose fin and a coded wire tag were considered integrated hatchery-origin.

REPORT CHAPTERS AND TOPICS

This report documents status and trends in spawner abundance and productivity of Chinook Salmon using data collected on Idaho's spawning grounds. Abundance of spawning salmon can fluctuate greatly and should be related to historic observations for proper interpretation. Chapter 1 reports annual redd counts at index transects surveyed during the historical peak spawning period, and compares current observations to select long-term data collected since the 1950s. In addition to a metric of relative spawner abundance such as redd counts, the adult-to-adult productivity of the population is essential to evaluate population status. Chapter 1 also reports spawner composition metrics necessary to quantify productivity (i.e. age composition, hatchery fraction), and uses that information to quantify adult-to-adult productivity through the most recently completed brood year.

Chapter 2 focuses on a unique MPG by analyzing the persistence and spatial dynamics of Chinook Salmon in Idaho's pristine Middle Fork Salmon River basin. A long-term plan for annual spawning ground surveys in the Middle Fork Salmon River wilderness was developed for this basin in 2018 and was provided in a previous version of this report (Felts et al. 2019, Appendix A).

Additional data not related to specific chapter objectives are often collected during spawning ground surveys and hatchery weir operations. This annual report also serves to document those collection efforts or any changes to our standard efforts. Appendix A documents data collected at hatchery weirs and during multiple pass redd counts.

DATA MANAGEMENT AND ACCESS

Throughout this report we refer to populations designated by the Interior Columbia Basin Technical Recovery Team (ICBTRT 2003, 2005). Because some of these names are quite long, we use our own abbreviations (see Abbreviations and Acronyms page) to describe populations in tables and figures.

Data management follows protocols detailed in Copeland et al. (2019). Spawning ground survey (SGS) data, including redd count and carcass survey data, are recorded in the field on standardized paper data sheets and with global positioning systems (GPS) devices. Waypoints are captured for new redds, carcasses, and survey boundaries using standardized naming conventions. Personnel from IDFG and the Shoshone-Bannock Tribes enter index and non-index survey data into a local Spawning Ground Survey application (SGSA), and the GPS data are imported into their respective surveys in the SGSA. The data are quality checked by the compilers against the paper survey forms. The waypoint data are visually inspected by the compilers to ensure accuracy in the SGSA. Upon verification of complete and correct surveys, the data are uploaded to the centralized, Microsoft Sequel Server SGS database. Other organizations such as the Nez Perce Tribe send index count data to IDFG biologists who then enter it into a local SGSA. The transferred index data are checked for completeness and correctness by data managers, and corrections are uploaded from their SGSA to the SGS database if necessary. Non-index data collected by other organizations are housed and maintained in their separate databases. The data from all compilers are accessible with permission from Idaho Department of Fish and Game (IDFG) in read-only views from the Idaho Fish and Wildlife Information System (IFWIS) web reports, which query the SGS database: https://fishandgame.idaho.gov/ifwis/portal.

Carcass sample data - such as fin ray, genetic, and otolith data - that are recorded on the spawning grounds are entered into SGSA, uploaded to the SGS database, and then transferred from the SGS database to the BioSamples database, which is located on a Microsoft Sequel Server. The transfer is performed by the ageing laboratory coordinator who uses a data template in Microsoft Excel to reformat data from the SGS database for entry into the BioSamples database. A unique fish identification code from the SGS database is entered into the BioSamples database to assist in joining the two databases. Carcass records in the SGS database with fin ray samples are joined to the ageing data in the BioSamples database using the unique fish identification code and the sample number. When the fin rays are analyzed, the estimated age from the BioSamples database populates the Estimate Total Age field in the SGS database.

For the purposes of this report, all index and census redd survey data were entered into preformatted tables by biologists responsible for their collection. Length and fin ray age data were downloaded from the BioSamples database on 23 February 2022. Adult weir and trap data are stored in and accessed from the Fish Inventory System Hatchery Database https://www.finsnet.org/#. These data include all adult Chinook Salmon that are trapped, spawned, or released to spawn naturally. Weir and trap genetics sample data were downloaded from the IDFG Eagle Fish Genetics Laboratory Progeny database on 22 February 2022.

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FIGURES

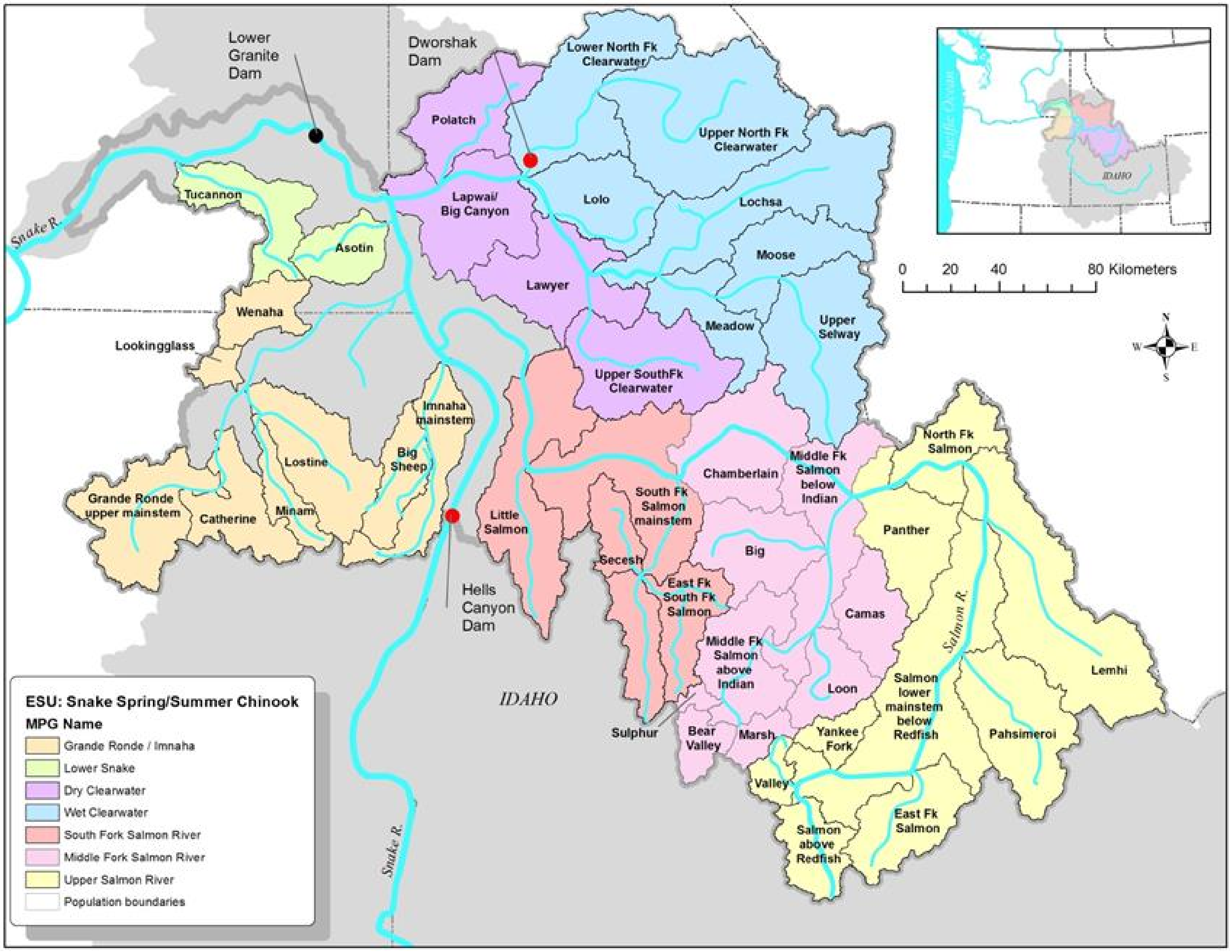

Figure 1. Spring-summer Chinook Salmon independent populations and major population groups (MPGs) in the Snake River evolutionary significant unit (ESU). Red dots represent impassable dams.

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CHAPTER 1. RELATIVE ABUNDANCE AND PRODUCTIVITY IN IDAHO POPULATIONS OF SPRING-SUMMER CHINOOK SALMON

ABSTRACT

The Idaho Salmon and Steelhead Monitoring and Evaluation Studies project monitors the status of Snake River spring-summer Chinook Salmon *Oncorhynchus tshawytscha* populations in the Salmon River and Clearwater River basins. Annual single-pass redd counts and carcass surveys are conducted at index transects and provide estimates and temporal trends of relative abundance and productivity. In 2021, a total of 1,496 redds were counted at 100 transects covering 1,236.8 km, 27 populations, and five major population groups. Relative abundance in 2021 was higher than in 2020 in the Clearwater River basin and lower in the Salmon River basin. In most populations, relative abundance has decreased in many Idaho populations since 2014 and remain well below the pre-dam era range for all populations. The brood year 2017 cohort, represented by age-4 fish on the spawning grounds in 2021, was the most common among all age classes observed. Adult-to-adult productivity estimates for the brood year 2016 cohort are now complete, and were less than one recruit per spawner for every population except Valley Creek and Marsh Creek.

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INTRODUCTION

Abundance is an essential metric in monitoring fish populations as it represents the end product of the interplay between three processes considered to be the pillars of fisheries management (recruitment, growth, and mortality: Ricker 1975; Allen and Hightower 2010). Population status is often assessed by using current abundance estimates to predict extinction risk and future trends (McElhany et al. 2000). The direct link between population processes and abundance have led to the latter being designated as a critical metric in assessing viability of salmonid populations (ICBTRT 2005).

Understanding the relationship between spawner abundance and recruitment of a new generation of spawners is important when managing fish populations. In semelparous fishes such as Chinook Salmon *Oncorhynchus tshawytscha*, estimation of adult-to-adult productivity is straightforward if abundance and age composition of spawners is quantified annually (Myers et al. 1999). This metric represents the integrated effects of factors such as population density, environmental conditions, and ecological conditions throughout the entire life cycle (McElhany et al. 2000). Adult-to-adult productivity offers an indication of population trends that is robust to annual fluctuations in spawner abundance. If population abundance is below a desired threshold, as is the case for all spring-summer Chinook Salmon populations in Idaho (NMFS 2016), productivity must, on average, exceed replacement for abundance to increase. As such, adult-to-adult productivity and abundance are given the highest priority in assessing viability of salmonid populations (McElhany et al. 2000, ICBTRT 2005).

In this chapter, relative abundance of Snake River spring-summer Chinook Salmon (hereafter Chinook Salmon) spawning in Idaho in 2021 is summarized using single-pass redd counts. Redd counts are commonly used as a *relative* index of population abundance across space and time. Nonetheless, redd counts were the basis for the decision to list Snake River spring-summer Chinook Salmon as threatened under the ESA (Matthews and Waples 1991). Hence, continuous standardized redd count data were used to compare 2021 relative abundance to the most recent 5-year period, to the 1957-1969 pre-dam era, and across the Idaho landscape. Specific objectives were to:

1) Quantify spawner relative abundance for 27 Idaho populations of Chinook Salmon that were surveyed in 2021.

2) Quantify adult-to-adult productivity using completed brood years for 19 Idaho populations of Chinook Salmon where sufficient data were available.

METHODS

<u>Study Design</u>

Stream transects targeted for redd counts in 2021 were selected based on long-term monitoring conducted by Idaho Department of Fish and Game (IDFG) and collaborators (Table 1-1). Standardized sampling of trend transects began as early as 1957 (Hassemer 1993; Copeland et al. 2019). Trend transects were selected to represent important production areas containing a large portion of available spawning habitat (Copeland et al. 2019). Transects have been added or dropped periodically over the course of the program's history, so the amount of habitat surveyed has changed over time (Copeland et al. 2019). Transect distances were refined in 2020, reflecting the use of updated GIS layers (Felts et al. 2020, Appendix C). Trend surveys were timed to coincide with the period of peak spawning activity on a particular stream as estimated from historical observations (Copeland et al. 2019). The timing of trend surveys ranges from mid-August to late September (Table 1-1)

Data Collection

Observers conducting surveys in Idaho were trained annually to accurately determine and record redds and sample carcasses during surveys in a standardized manner. Redd counts were conducted by trained observers who attended a training workshop hosted by the Idaho Department of Fish and Game near Stanley, Idaho on August 17, 2021. Workshop attendees were trained to identify redds by the presence of two features: 1) a "pit" resulting from excavation of the redd and covering of the eggs, and 2) tailspill, which is defined by the presence of loose substrate immediately downstream of the excavated pit (Burner 1951; Hassemer 1993). Training emphasizes the "four D's" (disturbance, digging, definition, and deposition) as criteria indicating a completed redd.

Surveys were conducted by walking, floating, or flying a single pass along the designated transect and examining the streambed for redds (Table 1). Redds were identified by the presence of two features: 1) a "pit" resulting from excavation of the redd and covering of the eggs, and 2) tailspill, which is defined by the presence of loose substrate immediately downstream of the excavated pit (Burner 1951; Copeland et al. 2019). Aerial surveys were conducted in a few instances with either low-flying helicopter or unmanned aircraft systems (UAS). Surveys by UAS in the Upper Salmon River Lower Mainstem population involved subsampling five transects as described in Nau et al. (2020), Appendix C. All redds were enumerated and georeferenced using GPS units.

Chinook Salmon carcasses encountered during ground surveys were sampled to determine origin, estimate age composition, and to collect tissue for genetic analysis. Supplemental surveys were also conducted for the sole purpose of collecting biological information from carcasses. Carcasses were first identified as either natural- or hatchery-origin based on where they were produced and as indicated by marks and tags. All carcasses encountered were visually inspected for an adipose or other fin clip and scanned for a coded wire tag (CWT) and passive integrated transponder (PIT) tag. Carcasses with an adipose fin clip were considered segregated hatchery-origin. Carcasses with a CWT and an intact adipose fin were considered integrated hatchery-origin. All other carcasses with an intact adipose fin were considered natural- or wild-origin. Some hatchery release groups from the Clearwater basin did not receive an adipose fin clip or a CWT.

Each carcass was inspected for any other marks and tags, measured for fork length (mm), and examined internally to determine sex. Dorsal fin ray and tissue samples were taken from all natural carcasses when feasible. Four to five fin rays were collected, placed in a coin envelope, and frozen. Tissue samples were collected from the least decayed fin and stored on a piece of paper inside separate coin envelopes. Fin ray and tissue samples were delivered to IDFG's Nampa Research Anadromous Ageing Laboratory (NRAAL) located in Nampa, Idaho.

Once delivered to NRAAL, dorsal fin rays were processed and assigned a saltwater age. Fin rays were dried, set in epoxy resin, cut into cross sections with a TechCut 5™ Precision High Speed Saw, and mounted on microscope slides using Shandon-Mount™. Mounted fin rays were digitally imaged using a Leica DFC 450 microscope camera attached to a Leica DM1000 LED microscope. Imaged fin rays were read independently by two trained readers and discrepancies were re-examined in a referee session until both readers and a third party came to a consensus.

If a consensus could not be reached, the sample was removed from analysis. Total age (hereafter age unless otherwise denoted) was assigned by adding assumed freshwater age to assigned saltwater age. All freshwater ages were assumed to be 2 years old. This step allows us to assign fish to the correct brood year. To assess the accuracy of our age assignments, fin ray samples from known-age fish were mixed into the overall sample. Smolts marked with PIT tags or CWTs and recovered during hatchery spawning or carcass surveys were considered known-age.

In addition to ages obtained from fin ray samples, age composition data is also obtained from in-stream array detections of PIT-tagged individuals previously sampled at Lower Granite Dam. These additional samples bolster sample size, particularly in remote populations where few carcasses are encountered during spawning ground surveys. Final detections of PIT-tagged adults at sites with in-stream arrays, weirs, or hatchery traps which could be assigned to independent populations were queried to obtain age composition data from the IDFG BioSamples database; these data are accessible to collaborators upon request (Table 1-2). Scale samples are taken from adipose-intact adults sampled at Lower Granite Dam (Camacho et al. 2018). Technicians at NRAAL process scale samples and assign ages according to protocols detailed in Wright et al. (2015). When PIT-tagged fish were also recovered from carcass surveys and assigned an age from a fin ray sample, the fin ray age assignment was used in further analysis.

Data Analysis

The number of redds counted in index transects in 2021 was summed by population and plotted alongside observations from the recent era (previous five years, 2016-2020) and from the pre-dam era (13 years, 1957-1969). Geometric mean, minimum, and maximum number of redds were calculated for the pre-dam era comparison. This period also corresponds to the “pre-dam era” described in the Comparative Survival Studies (McCann et al. 2018).

Hatchery fraction was estimated as the proportion of carcasses which were hatchery-origin within populations. For populations with hatchery weirs, hatchery fraction was estimated at the population level, and separately above and below the weir. In populations where no carcasses were recovered, hatchery fraction was assumed to be 0 if there were no hatchery releases within the population. Carcasses were recovered in all populations with intended hatchery releases in 2021 so no assumptions were necessary for these populations.

Performance of NRAAL age assignment from fin rays was evaluated using a combination of metrics and graphical assessment. Accuracy was assessed using root mean squared error (RMSE), percent agreement (PA) between assigned and known age, and age bias plots. The RMSE was calculated as the square root of the mean squared difference between the assigned age (A_e) and the known age (A_k):

$$RMSE = \sqrt{(A_e - A_k)^2}$$

Percent agreement was calculated as the number of samples for which assigned age was equal to known age divided by the total number of known-age samples, then multiplied by 100. An age bias plot was constructed to depict the relationship between known age and assigned age for a group of samples. Accuracy metrics and age bias plots were computed using the base and ggplot2 (Wickham 2009) packages in Program R (R Core Team 2017).

Population-specific age composition for 2021 was estimated directly using the age class proportions of sampled fish observed in each population, or from age class proportions in the MPG aggregate, depending on sample size. If at least 20 samples in a population were assigned an age from fin rays or scales, then age composition was estimated directly (Felts et al. 2019). If at least 20 samples in a population were assigned an age, but additional carcasses were measured for fork length and not assigned an age, then an age-length key was constructed for natural-origin fish using methods described by Isley and Grabowski (2007). In this scenario, the combined sample of assigned ages and indirect ages from the age-length key was used to estimate population-specific age composition. If less than 20 samples in a population were assigned an age, then the aggregate age composition for the MPG was taken to represent population-specific age composition. Age composition at the MPG level was calculated using the same methods described for populations. If less than 20 samples in an MPG were assigned an age, then the aggregate age composition for the ESU was taken to represent population-specific age composition within that MPG. In addition to overall age composition, adult age composition was estimated by excluding age-3 fish. This metric was calculated because age-3 fish are almost exclusively males, whereas our index of abundance is derived from redds which are constructed by the female population.

Adult-to-adult productivity was updated through brood year 2016 for this report. The number of redds counted during a given brood year was taken as a measure of "stock." Adult returns ("recruits"), which excluded jacks, were calculated by estimating the number of natural-origin redds produced from a brood year at age 4, 5, and 6:

$$R_j = (age4prop_{j+4} * wr_{j+4}) + (age5prop_{j+5} * wr_{j+5}) + \ (age6prop_{j+6} * wr_{j+6})$$

where R_j is recruits (natural-origin redds) from brood year j, *ageXprop* is the proportion of adults which were age *X*, and *wr* is the estimated number of natural-origin redds. Natural-origin redds was estimated by multiplying wild fraction (1 minus hatchery fraction) by the total number of redds counted in index transects within populations. Adult age composition was applied because age-3 fish, which were primarily males, were assumed to have no effect on redd abundance (Quinn 2018). Age composition dating back to brood year 2001 was calculated using the methods described above for the current year's age composition. This time series was selected to characterize productivity over the three most recent brood cycles. The estimated number of natural-origin redds was used for returning redds because we were primarily interested in how many returning redds were produced by natural-origin Chinook Salmon. Clearwater River basin populations were omitted from productivity analysis because of inconsistency in transect boundaries and uncertainty associated with estimates of hatchery fraction. Panther Creek and Yankee Fork Salmon River were omitted for the same reasons, and the Little Salmon River did not have sufficient data because index transects were not established until 2017.

RESULTS

During August and September 2021, 100 transects covering 1,236.8 km of streams in Idaho were surveyed for Chinook Salmon redds (Table 1-3). A total of 1,496 redds were counted in index transects across five MPGs and 27 populations in the Salmon River and Clearwater River basins. Sixty-seven percent of redds were counted in the Salmon River basin (Table 1-3; Figure 1-1; Figure 1-2). Number of redds were highest in the Upper South Fork Clearwater, the Upper Salmon River above Redfish Lake Creek, the South Fork Salmon River mainstem and Bear Valley Creek. (Table 1-3). Hatchery fraction was highest at 80% in the Upper South Fork Clearwater River. Only natural-origin carcasses were recovered in Bear Valley Creek, Marsh Creek, Panther Creek, and the Lemhi River.

All index transects in the South Fork Salmon River MPG were surveyed, which included 112.3 km of current spawning habitat. The total number of redds counted ranged from two redds in the Little Salmon River to 160 redds in the South Fork Salmon River mainstem (Table 1-3; Figure 1-2). Redd abundance within this MPG in 2021 was below the pre-dam era range for the South Fork Salmon River mainstem. Hatchery-origin fish composed 53% of carcasses in the East Fork South Fork Salmon River, 76% in the South Fork Salmon River downstream of the weir, 36% in the South Fork Salmon River upstream of the weir, and 7% in the Secesh River (Table 1-4). All hatchery-origin carcasses in the South Fork Salmon River upstream of the weir were from the integrated brood stock. No carcasses were recovered in the Little Salmon River.

All index transects in the Middle Fork Salmon River MPG were surveyed, which included 491.3 km of current spawning habitat. The total number of redds counted ranged from one redd in the Middle Fork Salmon River below Indian Creek to 112 redds in the Bear Valley Creek population (Table 1-3; Figure 1-3). Redd abundance within this MPG in 2021 was below the pre-dam era range for all populations. All carcasses collected during 2021 in the Middle Fork Salmon River MPG were natural-origin (Table 1-4). No carcasses were recovered in Chamberlain Creek, the Middle Fork Salmon River above Indian Creek, Camas Creek, Loon Creek, and Sulphur Creek.

All index transects in the Upper Salmon River MPG were surveyed, which totaled 510.3 km of current spawning habitat. The total number of redds counted ranged from two in the North Fork Salmon River to 196 in the Upper Salmon River mainstem above Redfish Lake (Table 1-3; Figure 1-4). Redd abundance within this MPG in 2021 was below the pre-dam era range for all populations except Panther Creek, and the Pahsimeroi River. The highest hatchery proportion in this MPG was 100% in the Pahsimeroi downstream of the weir; however, only one carcass was recovered (Table 1-4). Hatchery proportion was next highest at 57% in the Upper Salmon River downstream of the weir. Hatchery proportion in the Upper Salmon River upstream of the weir was 27% and was comprised of fish from integrated and segregate brood stocks. No hatchery carcasses were encountered in Panther Creek, the Lemhi River, and the Pahsimeroi River upstream of the weir. No carcasses were recovered in the North Fork Salmon River, the Salmon River Upper Mainstem below Redfish Lake Creek, and Yankee Fork Salmon River.

All index transects in the Dry Clearwater MPG were surveyed, which included 88.0 km of current spawning habitat (Table 1-3). Only one population in the Dry Clearwater MPG was sampled, the Upper South Fork Clearwater River because there is no evidence of substantial spawning by spring-summer Chinook Salmon in other populations. In 2021, 440 redds were counted for this population. The 2021 count was a major increase from the 80 redds observed in 2020 (Figure 1-5). Eighty percent of the carcasses collected in the Upper South Fork Clearwater population were hatchery-origin (Table 1-4). The Nez Perce Tribe Fisheries Program stocked adult Chinook into two tributaries of the South Fork of the Clearwater River a week prior to the surveys, thus the increase was caused by artificial stocking. Some hatchery release groups from the Dry Clearwater MPG did not receive an adipose fin clip or a CWT, so hatchery-origin fish was likely underestimated for this population.

All index transects in the Wet Clearwater MPG were surveyed, which comprised 34.9 km of current spawning habitat. Total number of index redds counted ranged from 0 redds in the Upper Selway River to 25 redds in the Lolo Creek (Table 1-3; Figure 1-5). The Lower North Fork Clearwater River and Upper North Fork Clearwater River populations are inaccessible to Chinook because Dworshak Dam prevents passage so no index transects exist. The Nez Perce Tribe stocks spring Chinook Salmon parr into the Meadow Creek population but surveys formerly conducted by Tribal staff, which documented natural production (e.g., Backman et al. 2007), have apparently lapsed and IDFG has never surveyed the stream. Seventeen known-origin carcasses were recovered in the Wet Clearwater MPG, and 5 of those were hatchery-origin (Table 1-4). Some hatchery release groups from the Wet Clearwater MPG did not receive an adipose fin clip or a CWT, so hatchery-origin fish was likely underestimated for this MPG.

In total, 1,165 natural-origin samples were assigned an age using fin rays or scales in 2021 (Table 1-5). Fin ray samples from carcasses accounted for 598, or about 51%, of the age assignments. Age assignments matched their known ages for 97.2% of the known-age fin ray samples (n =106), and the most common error was for known age-4 fish to be under-estimated by one year (n = 2; Figure 1-6). The brood year 2017 cohort, represented by age-4 fish on the spawning grounds in 2021, was the most common among all age classes observed within MPGs (Table 1-5) and across all samples (Figure 1-7). Age-3, age-5, and age-6 fish were also observed.

Adult-to-adult productivity over brood years 2002-2016 was estimated for 19 populations within the South Fork Salmon River, Middle Fork Salmon River, and Upper Salmon River MPGs. Temporal trends in productivity (returned redds per spawned redd) tracked similarly among populations over brood years 2002-2016 (Figure 1-8). Productivity in nearly all populations was below replacement for brood years 2002-2003, and above replacement for brood years 2006 and 2007. Productivity has been below replacement in nearly all populations for the last five completed brood years, 2012-2016. Time series of productivity by population for brood years 2002-2016 were provided (Figures 1-9 – 1-11).

DISCUSSION

Idaho Chinook Salmon redd abundance in 2021, measured by our standard index redd counts, was low compared to the past five years across Salmon River basin populations and high compared to the past five years across Clearwater River basin populations. The Clearwater River basin had the third highest count of redds observed in the 53-year history of data collection in the basin. The number of redds was 2.8 times the geometric mean over the entire history and 3.5 times the geometric mean over recent years. Despite this, nearly 75% of the carcasses observed in the Clearwater River basin in 2021 were hatchery origin, indicating that this precipitous increase was driven by intentional releases of hatchery-origin adults.

For Salmon River basin populations, the five-year range of recent observations has been below or near the low end of the pre-dam era range, indicating that even “good” runs in recent years were well below their potential. In a broader context, index redd counts within many populations were among the lowest observed in the 64-year history of this data set. We assume that low relative redd abundance indicates low absolute spawner abundance. Relative abundance within supplemented populations, including the South Fork Salmon River mainstem, the East Fork South Fork Salmon River, Pahsimeroi River, and Salmon River mainstem above Redfish Lake, has been within the pre-dam era range and near the geometric mean over recent years, but hatchery-origin fish constructed most of the redds in these populations. Thus, relative abundance in these populations as indicated by redd counts is augmented by hatchery production and should not be taken as an indication of better performance.

Redd numbers in the past three years have changed in different ways between the Clearwater and Salmon river basins. Extreme low values were recorded in 2019 in both basins. In 2020, the Salmon River basin exhibited a more dramatic increase than the Clearwater River basin. In 2021, a dramatic increase was observed in the Clearwater River basin, whereas the Salmon River basin had a slight decrease in redds. Most of the 2021 increase in the Clearwater

River basin was in the Upper South Fork Clearwater River population. Use of hatchery fish is carefully managed in the Salmon River basin; however, ESA constrains for spring-summer Chinook salmon do not apply in the Clearwater River basin and intentional and unintentional escapement of hatchery fish to spawning reaches is more frequent and of greater magnitude.

In addition to the index redd counts, samples from carcasses collected during surveys are used to produce productivity estimates which are used to assess population status and viability. The accuracy of these estimates relies on accurate aging of the samples. The Nampa Research Anadromous Ageing Lab (NRAAL) has an accuracy goal of >90% for total and saltwater age determination using fin rays (Wright et al. 2015). This standard is based on historical accuracy assessments of NRAAL age determination, and is met or exceeded in the vast majority of years in which accuracy has been assessed. In spawn year 2021, the accuracy of total age assignments exceeded this standard at 97.2%, and represents the percent agreement (PA) between known age samples and a multiple reader consensus read. Overall inaccuracies were biased toward under-aging, which accounted for all three disagreements between known total age and consensus age.

Productivity of brood year 2016 was below replacement in all 19 examined populations, except Marsh Creek and Valley Creek. Productivity has been below replacement for each of the last five completed brood years (2012-2016) across nearly all populations. Density-independent factors affecting survival through the hydrosystem and ocean have driven recent productivity trends for Snake River spring-summer Chinook Salmon (McCann et al. 2018). Ocean climatic conditions since 2013 have been especially abnormal and are suspected to have had a large negative impact on productivity of Pacific Northwest salmon (Peterson et al. 2018). A large area of abnormally warm water nicknamed the “Blob” stretched from the coast of Alaska to Baja California in the northeastern Pacific from late 2013 until late 2015 (Cavole et al. 2016). The elevated sea surface temperatures associated with the “Blob” reduced phytoplankton availability and caused several food web changes thought to reduce prey quality for Chinook Salmon (Cavole et al. 2016). Changes in forage fish abundance, distribution and spawning time have also been observed due to increased surface temperatures (Auth et al. 2017; Brodeur et al. 2019), contributing to changes in Chinook Salmon distribution in the Pacific Ocean as well (Shelton et al. 2020). The 2016 brood year cohort was the first cohort in several years to not have had any members migrate to the ocean into the Blob; despite that, increases in productivity were minimal. High temperature events have since reoccurred and will likely continue to occur periodically in the future (Scannell et al. 2020). The low productivity of recent brood years is likely due to those conditions because those brood years would have been exposed to the Blob or other high temperature events for part or all of their ocean phase.

Results from 2021 indicate Idaho populations of Chinook Salmon were at low spawner abundance relative to recent era and pre-dam era observations and NMFS recovery goals. The most recent status review for the Snake River spring-summer Chinook Salmon ESU concluded the majority of populations in the ESU continue to be at moderate-to-high risk and recommended no change in status (Ford 2022). Overall status has not improved since the previous status review. Low productivity has been observed since the 2015 status assessment, resulting in decreased abundance throughout the ESU. Poor ocean conditions have likely been a major driver of recent trends, and abundance is unlikely to increase to desired levels without favorable ocean conditions. Chinook Salmon have a high maximum annual reproductive rate (Myers et al. 1999), meaning populations can quickly increase in abundance when exposed to favorable conditions. NOAA annually assesses climatic, atmospheric, physical, and biological variables related to juvenile salmon survival and ranks them (https://www.fisheries.noaa.gov/content/ocean-conditions-indicators-trends). The ocean conditions in 2021 rank the second highest for juvenile salmon survival in the time series. Physical variables related to water temperature especially have improved compared to recent years. Changes in these density independent factors which affect productivity could quickly reverse recent trends.

Lastly, we continued survey designated transects in the Upper Salmon MPG using an Unmanned Aerial System (UAS or drone). In 2021, approximately 211 km was surveyed with a UAS. This effort was reduced from approximately 500 km in 2018-2019 and took approximately two weeks less time. An estimated 366 personnel hours were used for UAS surveys (i.e., driving and flying time). When surveys were completed, it took 6 personnel hours to import, upload, and safely store individual images in the database. Further image post processing was conducted by one biologist and one technician. This portion of the process took 32 hours. We also collaborated with researchers from Washington State University to investigate factors affecting redd detection by UAS. Selected transects were flown in Marsh Creek and the Salmon River to examine image quality as influenced by UAS specifications and the physical environment. Several preliminary recommendations were made and this work will continue in 2022.

RECOMMENDATIONS

1. Maintain the IDFG redd count index surveys.

2. Continue to evaluate potential spatial or temporal changes to index surveys relative to maintaining our ability to track long and short-term abundance trends in Chinook Salmon spawning in the Idaho.

3. Continue to refine spawning ground survey data management, from quality assurance in the field to quality control of the Spawning Ground Survey database and its output to ensure timely and accurate summaries.

4. Investigate factors affecting redd detection probability by UAS.

5. Analyze the sensitivity of age estimation errors on productivity metrics such as adult-to-adult productivity and smolt-to-adult return ratios.

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TABLES

Table 1-1. List of Idaho Chinook Salmon redd count index transects and 2021 sampling information. NS = Not Surveyed, NA = Not Applicable, NT= No index transects identified, NPT = Nez Perce Tribe, SBT = Shoshone-Bannock Tribes, UAS = Unmanned Aircraft System. See Abbreviations and Acronyms pages for population abbreviations.

Population	Transect ID	Target survey date	Actual survey date	Method	Agencies
		South Fork Salmon River MPG			
LSR	NS-34	9/5-9/10	9/9	Ground	IDFG
SFSR	NS-26	9/5	9/8-9/9	Ground	IDFG
	NS-27	9/5	9/2-9/3	Ground	NPT, IDFG
	NS-28	9/5	9/2-9/3	Ground	NPT, IDFG
	NS-29	9/6	9/1	Ground	IDFG
SEC	WS-16	8/25-9/1	9/1	Ground	NPT, IDFG
	WS-17	8/25-9/1	9/1	Ground	NPT, IDFG
	WS-18	8/25	8/31	Ground	NPT, IDFG
	WS-19	8/25	8/31	Ground	NPT, IDFG
	WS-20	8/25	8/31	Ground	NPT, IDFG
EFSFSR	NS-30	9/1-9/5	9/10	Ground	NPT, IDFG
	NS-31	9/1-9/5	9/20	Ground	NPT, IDFG
		Middle Fork Salmon River MPG			
CHC	WS-1	8/25	8/25	Ground	IDFG
	WS-1a	8/25	8/26	Ground	IDFG
MFSRL	WS-15c	9/5-9/12	9/12	Raft	USFS,IDFG
	WS-15d	9/5-9/12	9/12	Raft	USFS,IDFG
	WS-15e	9/5-9/12	9/12	Raft	USFS,IDFG
BIG	WS-13	9/5	8/30	Ground	NPT, IDFG
	WS-14a	9/5	8/30	Ground	NPT, IDFG
	WS-14b	9/5	9/9	Helicopter	IDFG
	WS-14c	9/5	9/9	Helicopter	IDFG
	WS-14d	9/5	9/10	Helicopter	IDFG
CAM	WS-8	8/25-9/5	9/11	Helicopter	IDFG
LOON	WS-6	8/25-9/5	9/12	Helicopter	IDFG
	WS-7	8/25-9/5	9/12	Helicopter	IDFG
MFSRU	WS-15a	9/5-9/12	9/8	Helicopter	IDFG
	WS-15b	9/5-9/12	9/8	Helicopter	IDFG
	WS-21	9/5-9/12	9/9	Helicopter	IDFG
	WS-22a	9/5-9/12	9/8	Helicopter	IDFG
	WS-22b	9/5-9/12	9/8	Helicopter	IDFG
	WS-23	9/5-9/12	9/12	Helicopter	IDFG
	WS-24	9/5-9/12	9/11	Helicopter	IDFG
SUL	OS-4	8/21	9/13	Helicopter	IDFG
	WS-12	8/21	9/13	Helicopter	IDFG
BVC	WS-9a	8/27	8/23	Ground	IDFG

Table 1-1 Continued.

Population	Transect ID	Target survey date	Actual survey date	Method	Agencies
		Middle Fork Salmon River MPG (continued)			
BVC, continued	WS-9b	8/27	8/23	Ground	IDFG
	WS-9c	8/27	8/25	Ground	IDFG
	WS-9d	8/27	8/24	Ground	IDFG
	WS-10a	8/27	8/24	Ground	IDFG
	WS-10b	8/27	8/24	Ground	IDFG
	WS-11a	8/27	8/24	Ground	IDFG/SBT
	WS-11b	8/27	8/24	Ground	SBT
	WS-11c	8/27	8/24	Ground	SBT
MAR	WS-2a	8/18	8/22	Ground	IDFG
	WS-2b	8/18	8/22	Ground	IDFG
	WS-3	8/17	8/23	Ground	IDFG
	WS-4	8/19	8/22	Ground	IDFG
	WS-5	8/16	8/20	Ground	IDFG
		Upper Salmon River MPG			
PAN	NS-11a	9/8	9/3	UAS	IDFG
	NS-11b	9/8	9/3	UAS	IDFG
	NS-11c	9/8	9/3	UAS	IDFG
	NS-11d	9/8	9/3	UAS	IDFG
NFSR	NS-25a	9/8	9/6-9/7	Ground	IDFG
	NS-25b	9/8	9/6-9/7	Ground	IDFG
	NS-25c	9/8	9/6-9/7	Ground	IDFG
LEM	NS-9	9/8	9/8	Ground	IDFG
	NS-10	9/8	9/22	UAS	IDFG
	NS-35a	9/8	9/9	Ground	IDFG
	NS-35b	9/8	9/9	Ground	IDFG
USRL	NS-17	9/8	9/7	UAS	IDFG
	NS-18	9/8	9/7	UAS/Estimate	IDFG
	NS-19	9/8	9/14	UAS	IDFG
	NS-20	9/8	9/8	UAS/Estimate	IDFG
	NS-21	9/8	9/21	UAS/Estimate	IDFG
	NS-22	9/8	9/16	UAS/Estimate	IDFG
	NS-23	9/8	9/21	UAS/Estimate	IDFG
PAH	NS-33a	9/20	9/20-9/21	Ground/UAS	IDFG
	NS-33b	9/20	9/21-9/23	Ground	IDFG
EFSR	NS-1a	9/8	9/13	Ground	IDFG
	NS-1b	9/8	9/13	Ground	IDFG
	NS-2a	9/8	9/13	UAS	IDFG
	NS-2b	9/8	9/14	Ground	IDFG
	NS-2c	9/8	9/13	UAS	IDFG

Table 1-1 Continued.

Population	Transect ID	Target survey date	Actual survey date	Method	Agencies
		Upper Salmon River MPG (Continued)			
YFK	NS-5	9/8	9/8	UAS	IDFG
	NS-6	9/8	9/13	UAS	IDFG
	NS-7	9/8	9/10	Ground	IDFG
	NS-8	9/8	9/10	Ground	IDFG
VAL	NS-3a	9/8	9/9	Ground	IDFG
	NS-3b	9/8	9/9	Ground	IDFG
	NS-4	9/8	9/9	Ground	IDFG
USRU	NS-12	8/31-9/5	9/2	Ground	IDFG
	NS-13a	9/8	9/7	UAS	IDFG
	NS-13b	9/8	9/7	UAS	IDFG
	NS-15a	9/8	9/8	Boat	IDFG
	NS-15b	9/8	9/8	Boat	IDFG
	NS-15c	9/8	9/7	UAS	IDFG
	NS-16	9/8	9/8	Ground	IDFG
	OS-1	8/31-9/5	9/3	Ground	IDFG
	OS-2	8/31-9/5	9/3	Ground	IDFG
	OS-3	8/31-9/5	9/3	Ground	IDFG
	OS-5	9/8	9/7	UAS	IDFG
	OS-6	9/8	9/7	Ground	IDFG
		Dry Clearwater MPG			
LAP	NT	NA	NA	NA	NA
LAW	NT	NA	NA	NA	NA
POT	NT	NA	NA	NA	NA
USFC	NC-1	9/3	9/6	Ground	IDFG
	NC-2a	9/3	9/7	Ground	IDFG
	NC-2b	9/3	9/8	Ground	IDFG
	NC-3	9/3	9/7	Ground	IDFG
	NC-4	9/1-9/5	9/3-9/5	Ground	IDFG
	NC-6	9/3	9/8	Ground	IDFG
	NC-8	9/3	9/16	Ground	NPT, IDFG
		Wet Clearwater MPG			
LNFC	NT	NA	NA	NA	NA
LOLO	NC-14	9/3	9/7	Ground	NPT, IDFG
LOC	NC-10	9/3	9/16	Ground	IDFG
	NC-11	9/3	9/14	Ground	IDFG
	NC-13a	9/3	NS	Ground	IDFG
	NC-13b	9/3	NS	Ground	IDFG
	NC-13c	9/3	NS	Ground	IDFG
MED	NT	NA	NA	NA	NA

Table 1-1 Continued.

Population	Transect ID	Target survey date	Actual survey date	Method	Agencies
		Wet Clearwater MPG (Continued)			
MOO	WC-3c	9/8	9/14	Ground	IDFG
	WC-3d	9/8	9/12	Ground	IDFG
SEL	WC-2	9/8	9/13	Ground	IDFG
	WC-5	9/8	NS	NA	NA
	WC-7	9/8	9/15	Ground	IDFG
UNFC	NT	NA	NA	NA	NA

Table 1-2. List of PTAGIS sites queried for PIT-tagged Chinook Salmon adults to obtain scale age assignments in 2021. See Abbreviations and Acronyms pages for population abbreviations.

Population	PTAGIS site code	Type
	South Fork Salmon River MPG	
LSR	RAPH	Hatchery Trap
SFSR	KRS	In-stream Array
	SALSFW	Hatchery Trap
	SFG	In-stream Array
SEC	ZEN	In-stream Array
EFSFSR	ESS	In-stream Array
	JOHNSC	Carcass Recovery
	Middle Fork Salmon River MPG	
BIG	TAY	In-stream Array
BVC	BRC	Weir
	Upper Salmon River MPG	
NFSR	NFS	In-stream Array
LEM	HYC	In-stream Array
	LLR	In-stream Array
	LRW	In-stream Array
PAH	PAHH	Hatchery Trap
YFK	YFK	In-stream Array
VAL	VC1	In-stream Array
USRU	SAWT	Hatchery Trap
	Dry Clearwater MPG	
USFC	CROOKR	Carcass Recovery
	SC1	In-stream Array
	SC2	In-stream Array
	Wet Clearwater MPG	
LOLO	LC1	In-stream Array
	LC2	In-stream Array
LOC	LRL	In-stream Array
	LRU	In-stream Array
MOO/SEL	SW1	In-stream Array
	SW2	In-stream Array

Table 1-3. Chinook Salmon redds counted in Idaho index transects in 2021. Hatchery fraction based on carcass information in Table 1-4 is also indicated. NT = No index transects identified, NA = Not Applicable. See Abbreviations and Acronyms pages for population abbreviations.

Population		**Length (km)**	**Redds**	**Hatchery fraction**
		South Fork Salmon River MPG		
LSR		3.8	2	0
SFSR		70.0	160	0.51
SEC		28.0	66	0.07
EFSFSR		10.5	82	0.53
	MPG Total	112.3	310	0.49
		Middle Fork Salmon River MPG		
CHC		7.8	6	0
MFSRL		107.5	1	0
BIG		63.6	41	0
CAM		9.9	10	0
LOON		24.4	9	0
MFSRU		179.1	14	0
SUL		9.5	5	0
BVC		62.9	112	0
MAR		26.6	67	0
	MPG Total	491.3	265	0
		Upper Salmon River MPG		
PAN		46.9	13	0
NFSR		29.3	2	0
LEM		48.8	41	0
USRL		138.3	31	0
PAH		45.8	39	0.14
EFSR		62.5	64	0.04
YFK		41.4	2	0
VAL		28.3	43	0.05
USRU		69.0	196	0.39
	MPG Total	510.3	431	0.33
	Salmon River Basin Total	1,113.9	1,006	0.33

Table 1-3. Continued.

Population	Length (km)	Redds	Hatchery fraction
Dry Clearwater MPG			
LAP	NT	NA	NA
LAW	NT	NA	NA
POT	NT	NA	NA
USFC	88.0	440	0.80
MPG Total	88.0	440	0.80
Wet Clearwater MPG			
LNFC	NT	NA	NA
LOLO	7.9	25	0.31
LOC	6.3	10	0
MED	NT	NA	NA
MOO	9.6	12	0
SEL	11.1	3	0
UNFC	NT	NA	NA
MPG Total	34.9	50	0.29
Clearwater River Basin Total	122.9	490	0.74
Idaho Total	1,236.8	1,496	0.78

Table 1-4. Chinook Salmon carcasses collected during spawning ground surveys in Idaho during 2021. Surveys are organized by major population group (MPG). F = female, M = male, U = unknown sex. Hatchery fraction is the number of hatchery-origin carcasses divided by the number of known-origin carcasses. Downloaded from SGS database on 1/18/22. See Abbreviations and Acronyms pages for population abbreviations.

	Integrated hatchery			Segregated hatchery			Natural			Unknown			Total			
Population	**F**	**M**	**U**	**F**	**M**	**U**	**F**	**M**	**U**	**F**	**M**	**U**	**All**	**Known-origin**	**Hatchery**	**Hatchery fraction**
South Fork Salmon River MPG																
LSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SFSR downstream of weir[e]	2	0	0	23	26	1	9	7	0	1	2	0	71	68	52	0.76
SFSR upstream of weir	5	4	0	0	0	0	5	11	0	0	0	2	27	25	9	0.36
SEC[a]	0	1	0	1	1	0	14	23	1	1	0	0	42	41	3	0.07
EFSFS [e]	11	18	0	0	1	0	9	18	0	0	0	0	57	57	30	0.53
MPG Total	18	23	0	24	28	1	37	59	1	2	2	2	197	191	94	0.49
Middle Fork Salmon River MPG																
CHC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MFSRU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MFSRL	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0
BIG	0	0	0	0	0	0	3	0	0	0	0	0	3	3	0	0
CAM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LOON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BVC[c]	0	0	0	0	0	0	10	11	1	0	0	0	22	22	0	0
MAR	0	0	0	0	0	0	30	33	1	0	0	1	65	64	0	0
MPG Total	0	0	0	0	0	0	43	45	2	0	0	0	91	90	0	0
Upper Salmon River MPG																
PAN[c]	0	0	0	0	0	0	4	13	0	0	0	1	18	17	0	0
NFSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LEM	0	0	0	0	0	0	7	2	1	1	0	0	11	10	0	0
USRL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 1.4 Continued.

Population	Integrated hatchery F	Integrated hatchery M	Integrated hatchery U	Segregated hatchery F	Segregated hatchery M	Segregated hatchery U	Natural F	Natural M	Natural U	Unknown F	Unknown M	Unknown U	Total All	Total Known-origin	Total Hatchery	Hatchery fraction
Upper Salmon River MPG (Continued)																
PAH downstream of weir	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
PAH upstream of weir	0	0	0	0	0	0	1	4	1	0	0	0	6	6	0	0
EFSR[c]	1	0	0	0	0	0	14	7	1	0	0	0	23	23	1	0.04
YFK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VAL	1	0	0	0	0	0	10	6	1	0	0	0	18	18	1	0.05
USRU downstream of weir	5	1	0	46	39	0	39	29	1	0	0	0	160	160	91	0.57
USRU upstream of weir	5	10	1	6	15	2	32	98	0	0	0	0	169	169	39	0.23
MPG Total	10	11	1	55	54	2	107	159	5	1	0	1	406	404	133	0.33
Dry Clearwater MPG																
USFC	2	0	0	71	26	2	11	6	8	5	3	0	134	126	101	0.80
MPG Total	2	0	0	71	26	2	11	6	8	5	3	0	134	126	101	0.80
Wet Clearwater MPG																
LOC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LOLO[e]	0	0	1	1	2	1	3	5	3	1	0	0	17	16	5	0.31
MOO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEL	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0
MPG Total	0	0	1	1	2	1	3	6	3	1	0	0	18	17	5	0.29

[a] Staff from the Nez Perce Tribe and Idaho Department of Fish and Game collected and provided information.
[b] Staff from U.S. Forest Service collected and provided information.
[c] Staff from the Shoshone-Bannock Tribes and Idaho Department of Fish and Game collected and provided information.
[d] Staff from the Shoshone-Bannock Tribes collected and provided information.
[e] Staff from the Nez Perce Tribe collected and provided information.

Table 1-5. Age composition of natural-origin Chinook Salmon estimated from carcasses collected during spawning ground surveys, natural-origin brood stock removed at weirs, and from PIT array detections in Idaho during 2020. NA = Not Applicable. See Abbreviations and Acronyms pages for population abbreviations.

Population	# Carcass fin ray samples	# PIT array scale samples	Length samples	# Total age samples	Freshwater.saltwater age (total age)			
					2.1 (3)	2.2 (4)	2.3 (5)	2.4 (6)
South Fork Salmon River MPG								
LSR	0	0	0	0	0	0	0	0
SFSR[a]	56	124	22	202	55	130	17	0
SEC[a]	84	70	31	185	35	142	8	0
EFSFSR[a]	68	20	27	115	40	67	8	0
MPG Total	208	214	80	502	130	339	33	0
Middle Fork Salmon River MPG								
CHC	0	0	0	0	0	0	0	0
MFSRL	1	0	1	2	0	2	0	0
BIG[a]	7	93	2	102	45	44	13	0
CAM	0	0	0	0	0	0	0	0
LOON	0	0	0	0	0	0	0	0
MFSRU	0	0	0	0	0	0	0	0
SUL	0	0	0	0	0	0	0	0
BVC[b]	20	49	19	88	6	53	29	0
MAR	58	0	59	117	9	78	30	0
MPG Total	86	142	81	309	60	177	72	0
Upper Salmon River MPG								
PAN	0	0	17	17	2	13	2	0
NFSR	0	0	0	0	0	0	0	0
LEM	9	32	9	50	10	34	6	0
USRL	0	0	0	0	0	0	0	0
PAH	39	22	6	67	6	54	7	0
EFSR	19	0	22	41	3	27	11	0
YFK	0	5	0	5	0	4	1	0
VAL	15	0	16	31	2	17	12	0
USRU	207	41	185	433	29	303	101	0
MPG Total	289	100	255	644	52	452	140	0
Salmon River Basin Total	583	456	416	1,455	242	968	245	0

Table 1-5. Continued.

Population	# Carcass fin ray samples	# PIT array scale samples	Length samples	# Total age samples	Freshwater.saltwater age (Total Age) 2.1 (3)	2.2 (4)	2.3 (5)	2.4 (6)
				Dry Clearwater MPG				
LAP	NA	NA	NA	NA	NA	NA	NA	NA
LAW	NA	NA	NA	NA	NA	NA	NA	NA
POT	NA	NA	NA	NA	NA	NA	NA	NA
USFC	9	25	17	51	4	39	7	1
MPG Total	9	25	17	51	4	39	7	1
				Wet Clearwater MPG				
LNFC	NA	NA	NA	NA	NA	NA	NA	NA
LOLO	5	6	9	20	0	18	2	0
LOC	0	38	0	38	6	26	6	0
MED	NA	NA	NA	NA	NA	NA	NA	NA
MOO[C]	0	0	0	0	0	0	0	0
SEL[C]	1	42	1	44	2	38	4	0
UNFC	NA	NA	NA	NA	NA	NA	NA	NA
MPG total	6	86	10	102	8	82	12	0
Clearwater River Basin Total	15	111	27	153	12	121	19	1
Idaho Total	598	567	443	1,608	254	1,089	264	1

[a] Staff from the Nez Perce Tribe and Idaho Department of Fish and Game collected and provided information.
[b] Staff from the Shoshone-Bannock Tribes and Idaho Department of Fish and Game collected and provided information.
[c] PIT array scale samples detected in the Selway River could potentially spawn in the SEL or MOO populations.

FIGURES

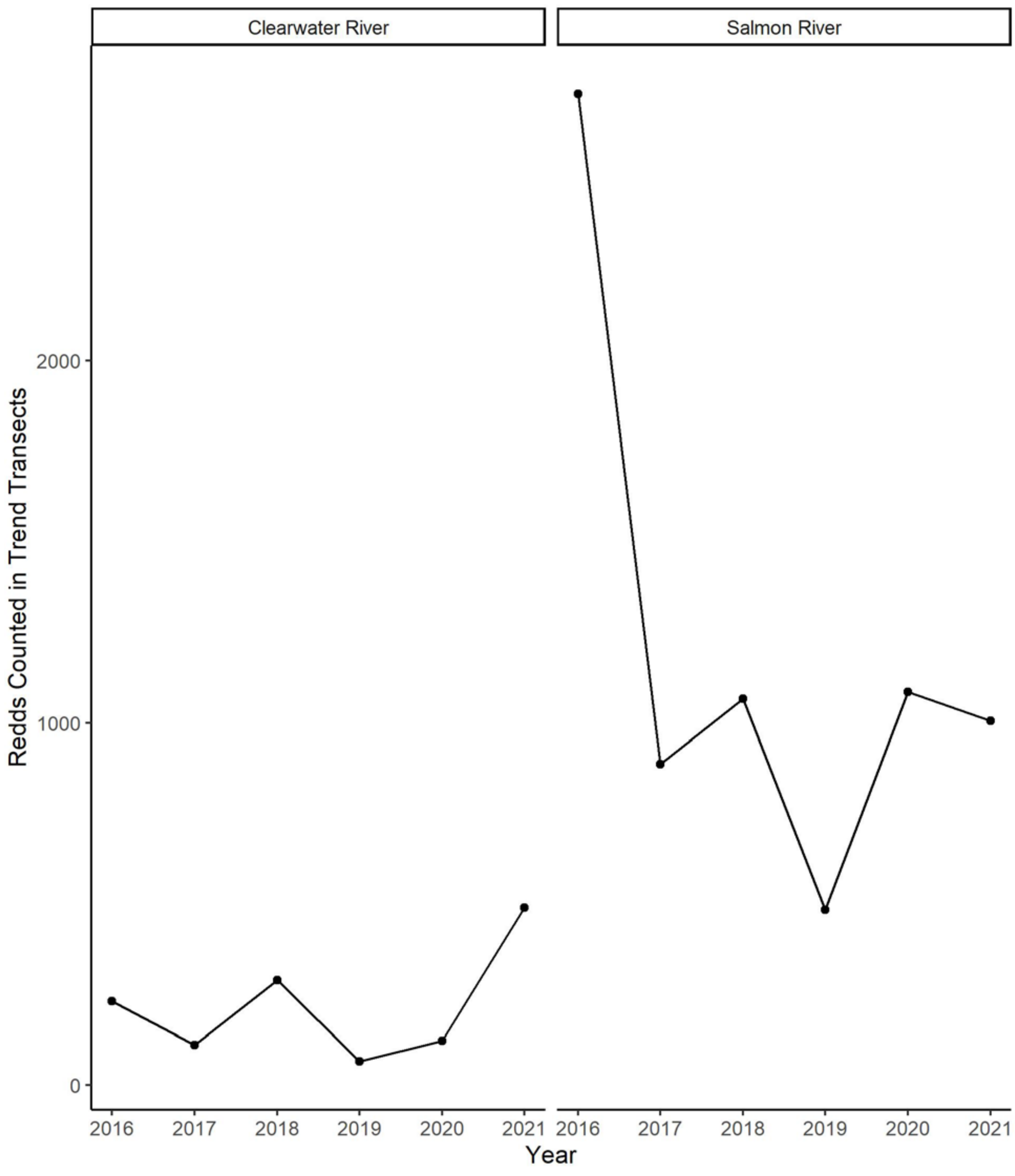

Figure 1-1. Number of Chinook Salmon redds counted in index transects of the Clearwater River (left panel) and Salmon River (right panel) basins from 2016 through 2021.

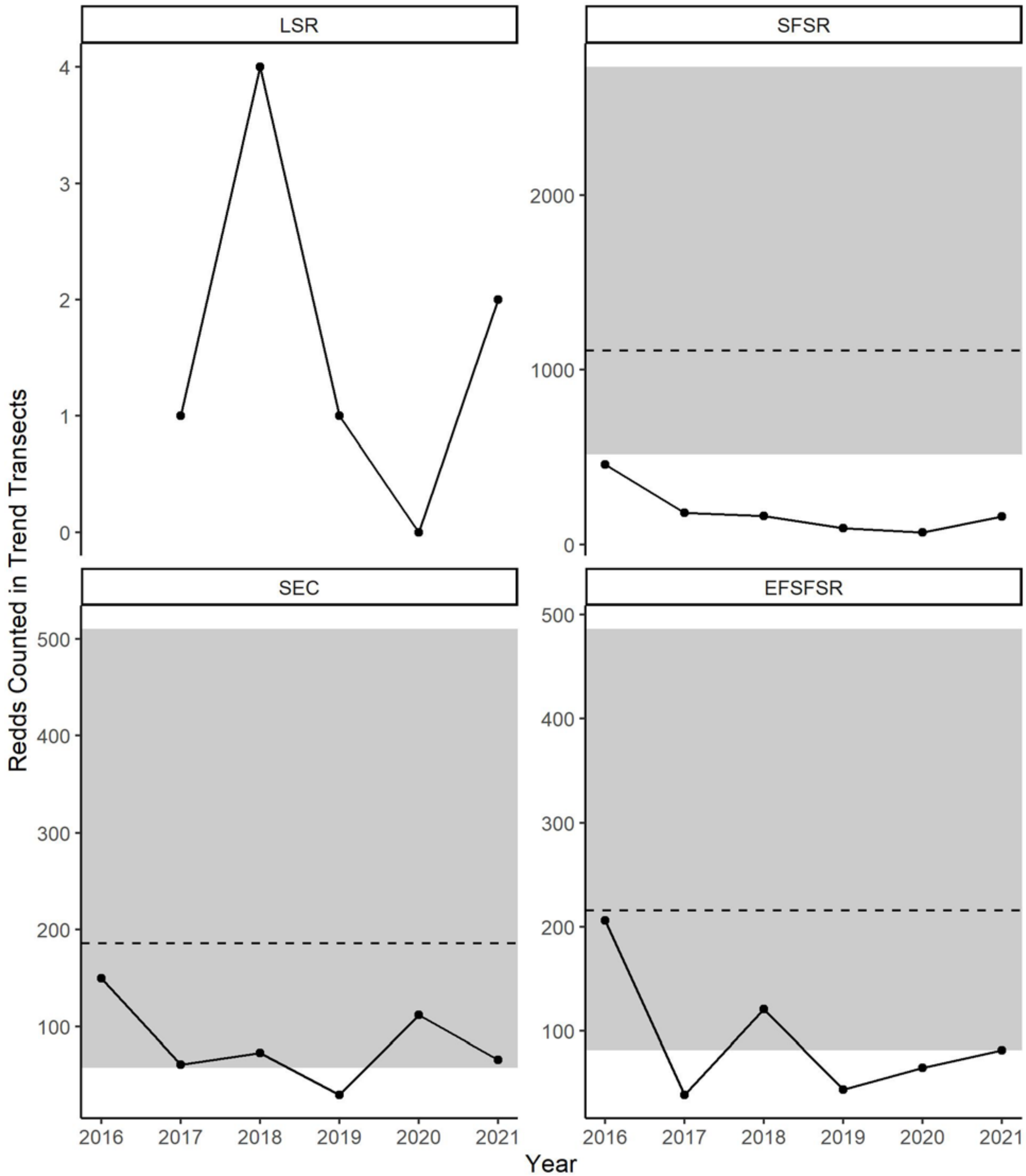

Figure 1-2. Number of Chinook Salmon redds counted in index transects of the South Fork Salmon River populations during the recent era, 2016-2021. Shaded area represents the pre-dam era range, and dashed reference line represents the pre-dam era geometric mean. No shading or dashed line represents lack of pre-dam era data. Note different y-axis scales.

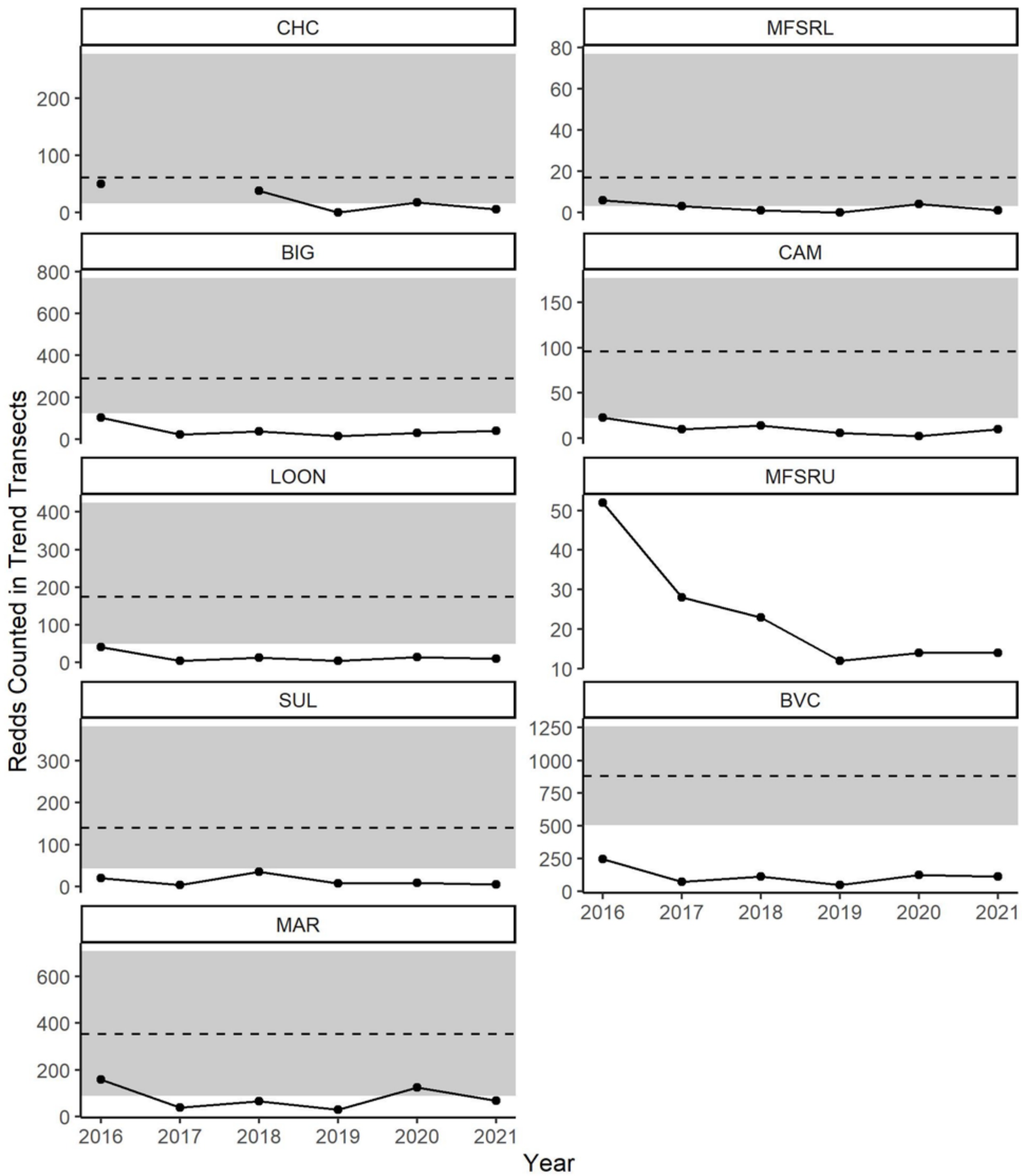

Figure 1-3. Number of Chinook Salmon redds counted in index transects of the Middle Fork Salmon River populations during the recent era, 2016-2021. Shaded area represents the pre-dam era range, and dashed reference line represents the pre-dam era geometric mean. No shading or dashed line represents lack of pre-dam era data. Note different y-axis scales.

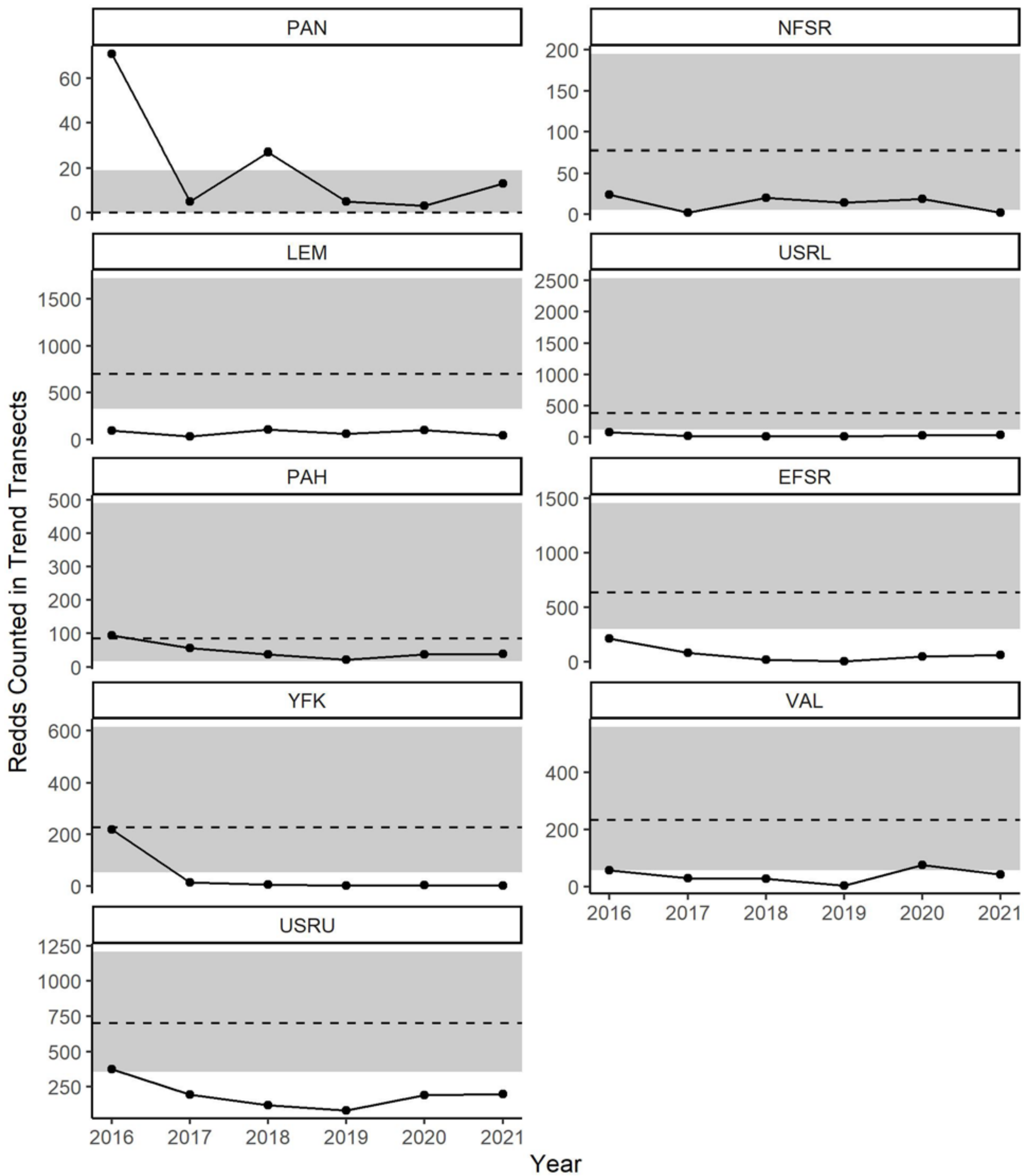

Figure 1-4. Number of Chinook Salmon redds counted in index transects of the Upper Salmon River populations during the recent era, 2016-2021. Shaded area represents the pre-dam era range, and dashed reference line represents the pre-dam era geometric mean. No shading or dashed line represents lack of pre-dam era data. Note different y-axis scales.

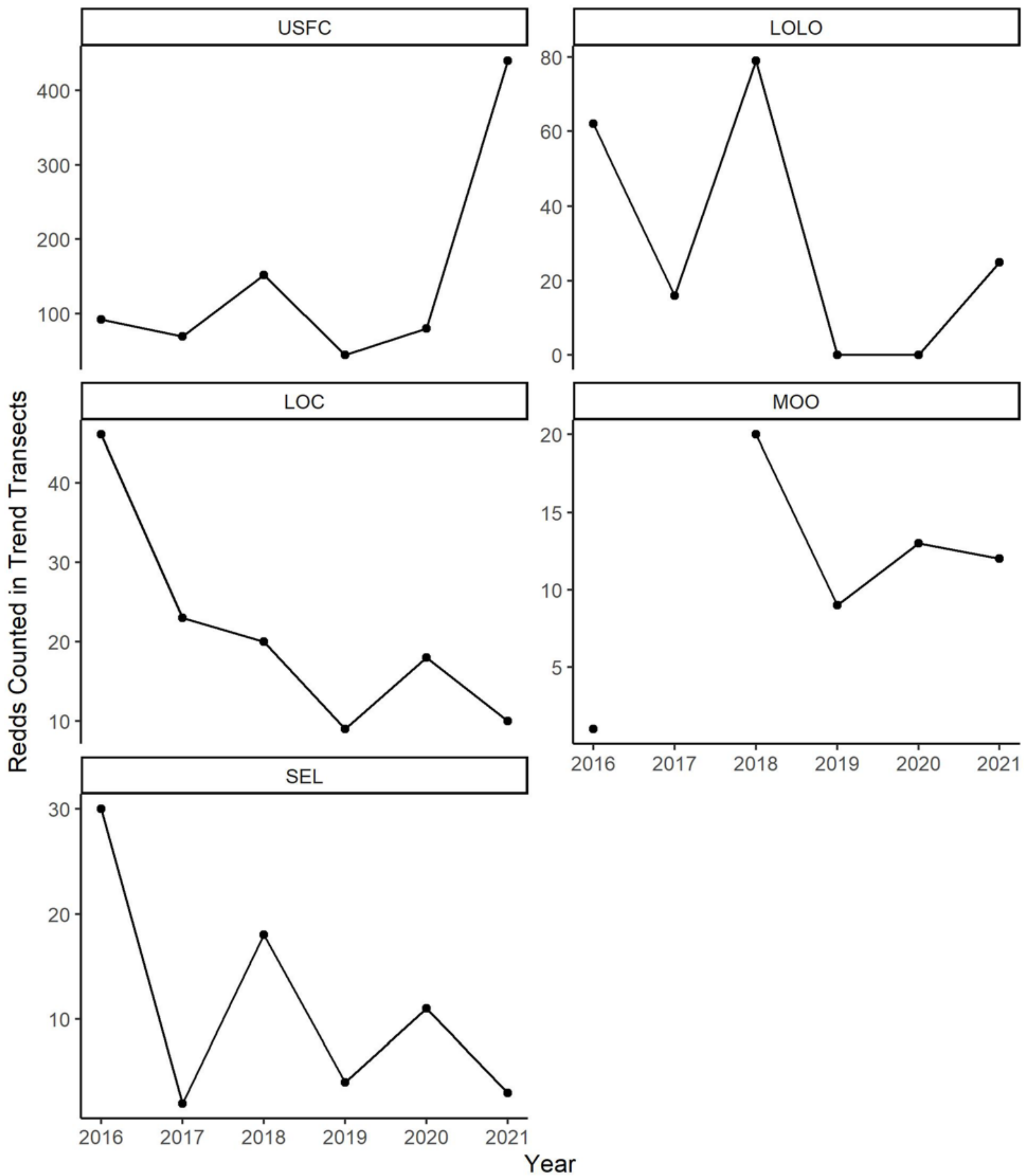

Figure 1-5. Number of Chinook Salmon redds counted in index transects of the Clearwater River basin populations during the recent era, 2016-2021.

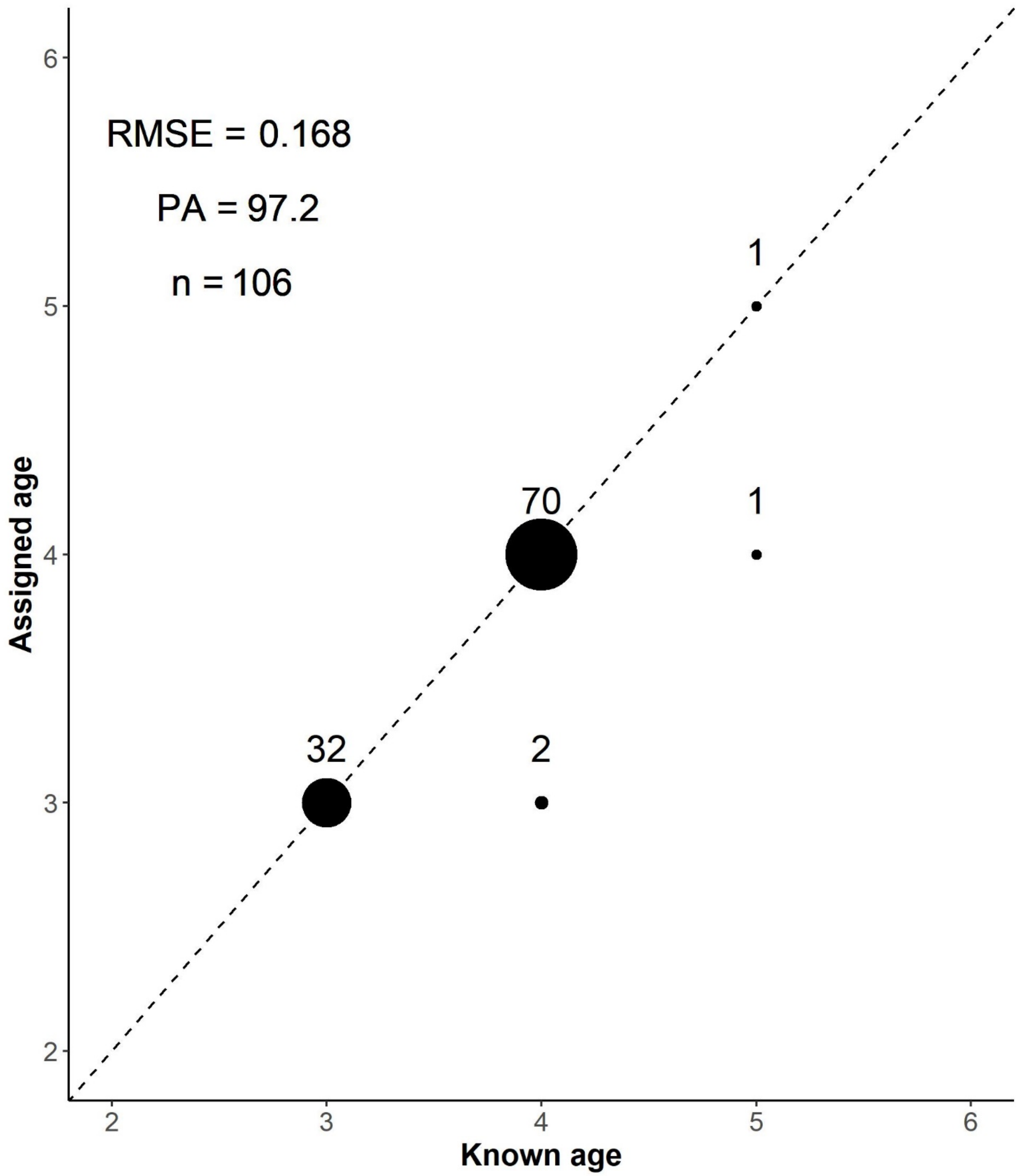

Figure 1-6. Age bias plot depicting the relationship between ages assigned to Chinook Salmon using fin rays and their corresponding known ages as determined by PIT tags and CWTs. All samples were collected in 2021. RMSE = root mean squared error, PA = percent agreement, and n = the number of known-age fish.

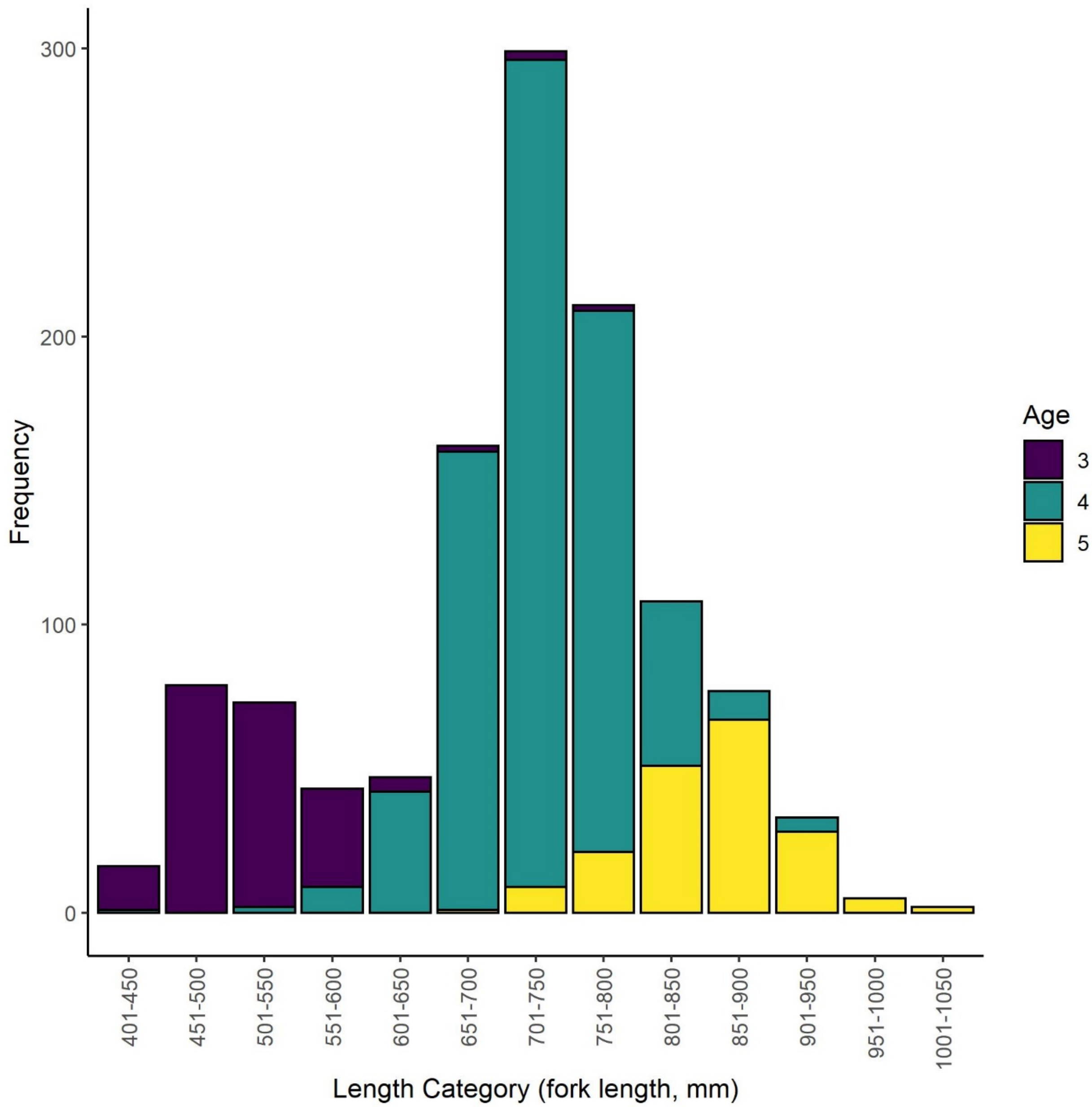

Figure 1-7. Length frequency distribution stacked by age class for natural-origin Chinook Salmon carcasses collected in Idaho during 2021 (n = 1,155).

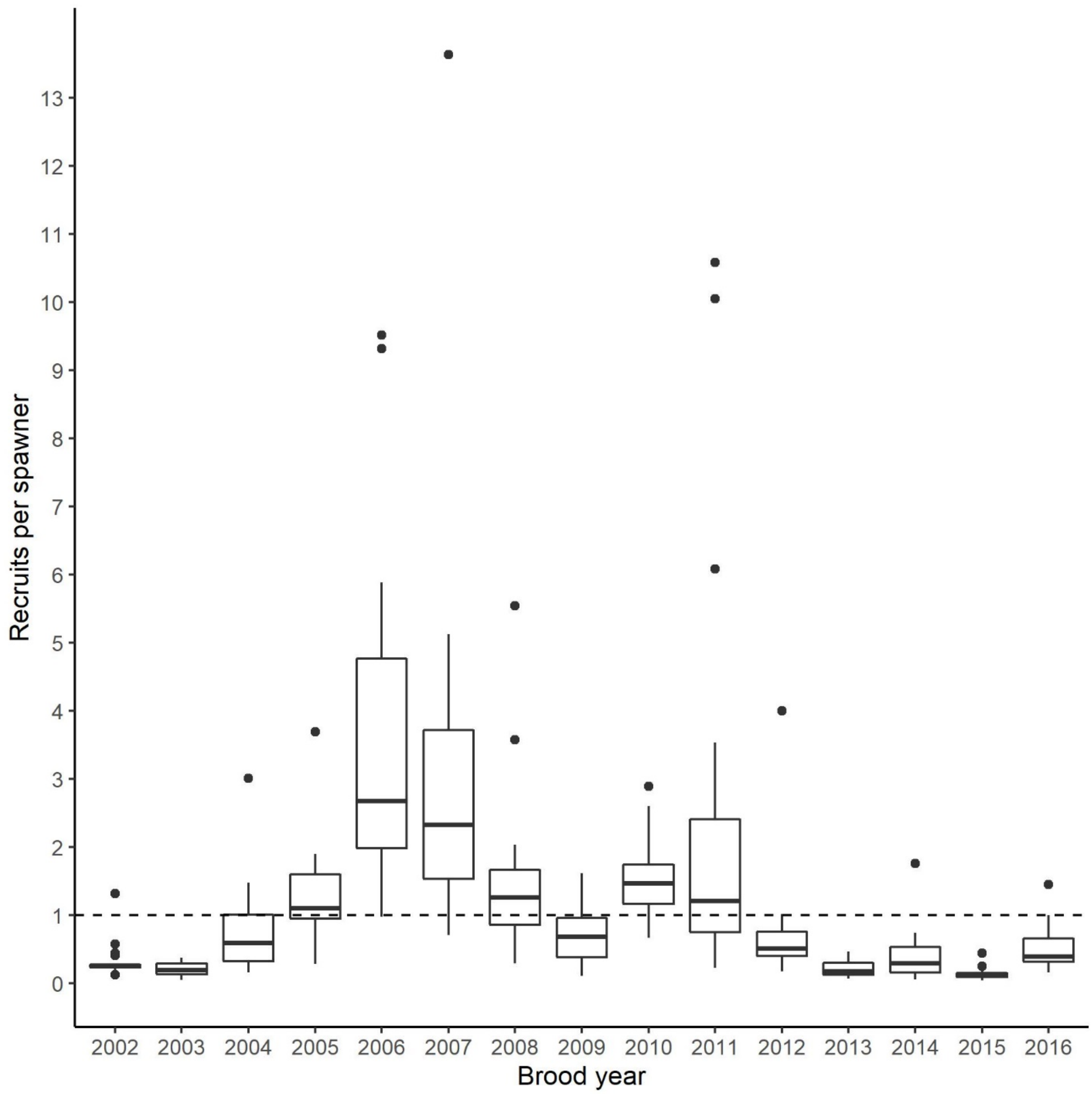

Figure 1-8. Box and whisker plot of productivity (natural-origin returned redds per spawned redd) estimates for 19 Chinook Salmon populations sampled in Idaho over brood years 2002-2016. Select populations in some years were omitted due to incomplete data (see Figures 1-11 to 1-13). Dashed line represents 1:1 replacement.

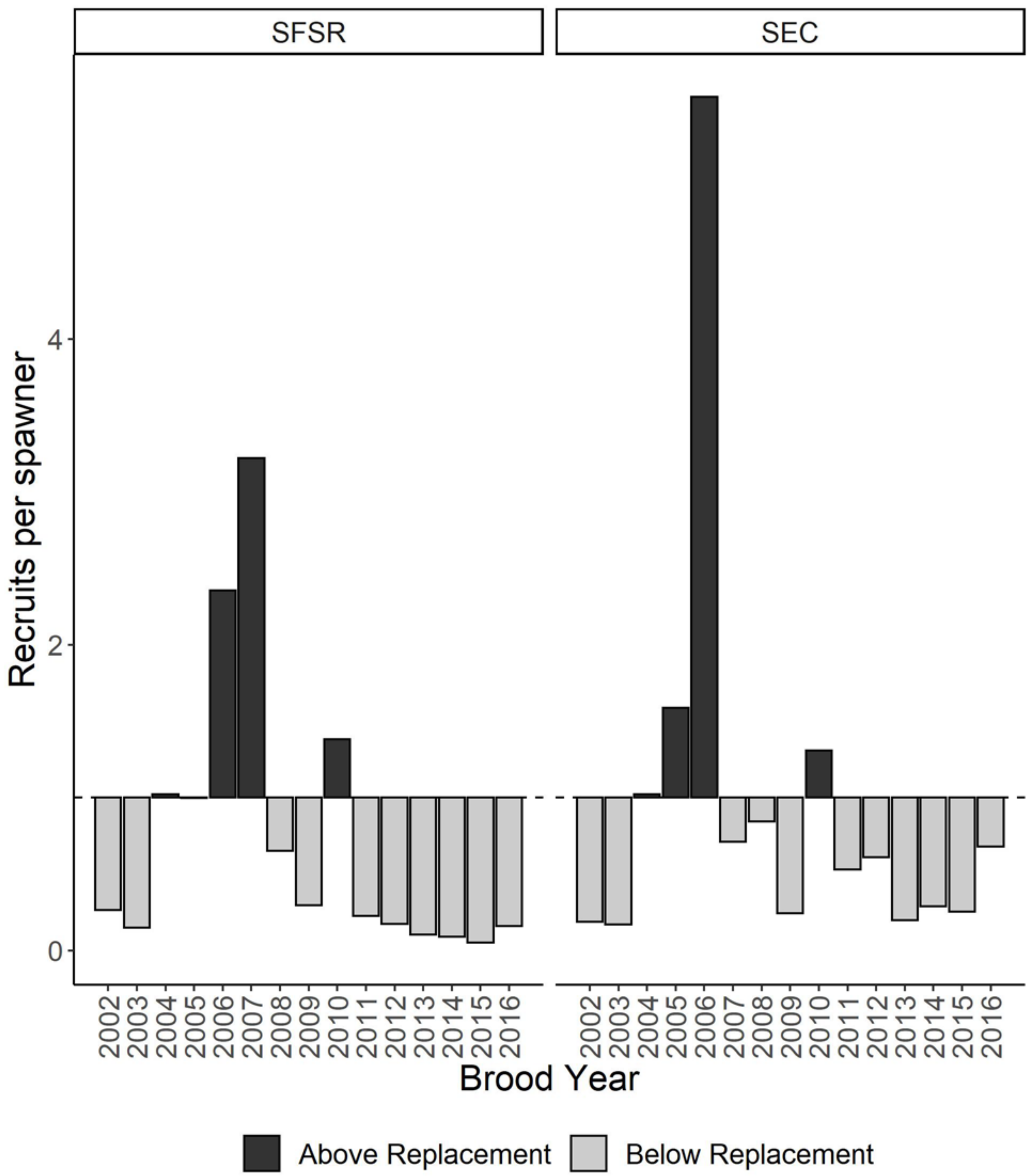

Figure 1-9. Productivity (natural-origin returned redds per spawned redd) of all South Fork Salmon River Chinook Salmon populations, except Little Salmon River and East Fork South Fork Salmon River, over brood years 2002-2016. Dashed line represents 1:1 replacement.

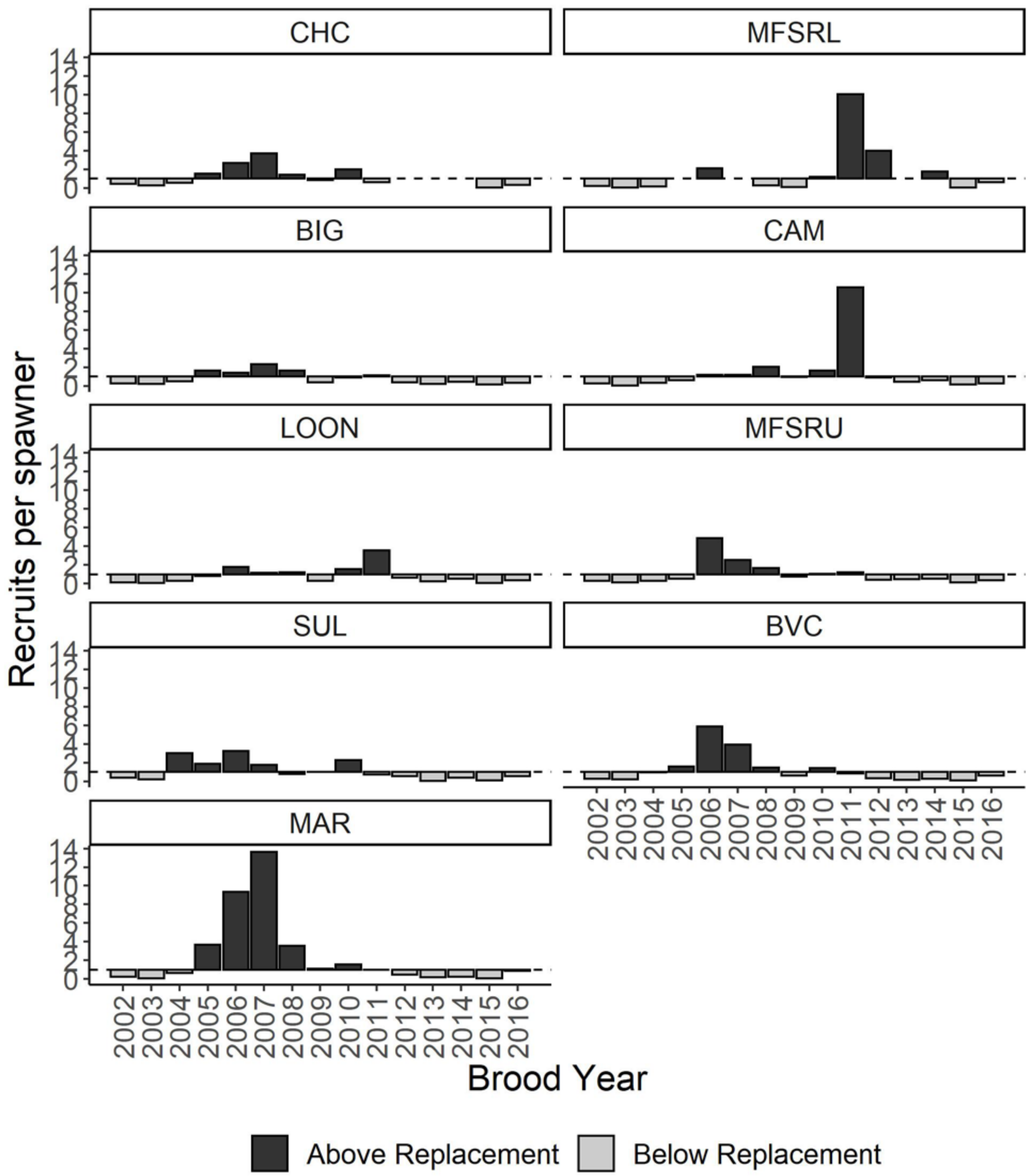

Figure 1-10. Productivity (natural-origin returned redds per spawned redd) of all Middle Fork Salmon River Chinook Salmon populations over brood years 2002-2016. Select brood years were omitted due to incomplete data. Dashed line represents 1:1 replacement.

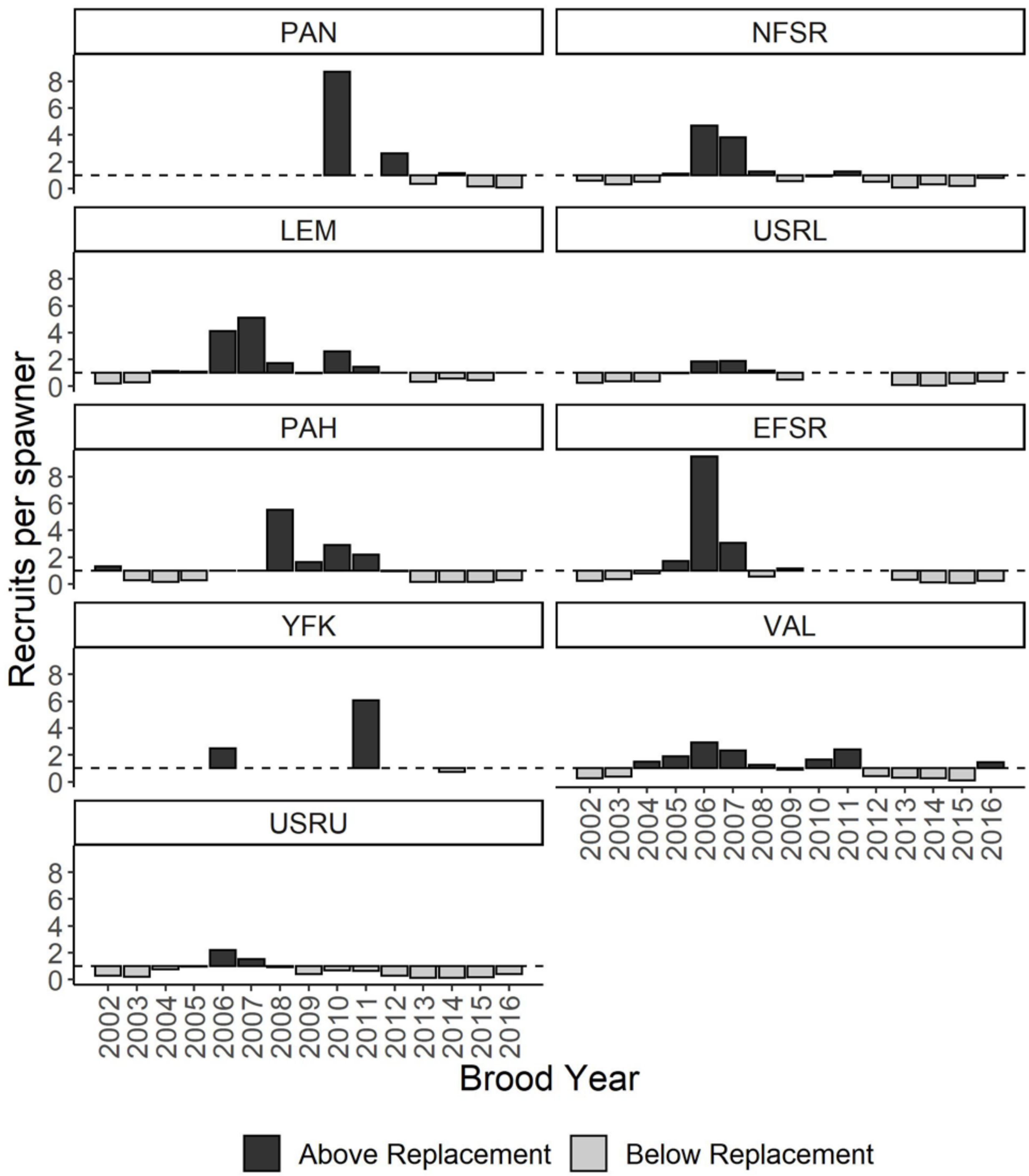

Figure 1-11. Productivity (natural-origin returned redds per spawned redd) of all Upper Salmon River Chinook Salmon populations over brood years 2002-2016. Select brood years were omitted due to incomplete data. Dashed line represents 1:1 replacement.

CHAPTER 2. DISTRIBUTION OF CHINOOK SALMON REDDS IN THE MIDDLE FORK SALMON RIVER BASIN, IDAHO

ABSTRACT

Intensive monitoring of redd distribution has been conducted in the Middle Fork Salmon River basin since 1995 to better understand spawning distribution of Chinook Salmon *Oncorhynchus tshawytscha*. In 2021, approximately 736 km of Chinook Salmon spawning habitat was surveyed for redds by air and ground, and a total of 362 redds were identified. These surveys cover approximately 260 km of Chinook Salmon Spawning that is not included in Idaho Department of Fish and Game index transects. Basinwide redd counts decreased from 2020 and were still well below the 1995-2019 average.

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INTRODUCTION

Snake River spring-summer Chinook Salmon *Oncorhynchus tshawytscha* have been listed as threatened under the Endangered Species Act (ESA) since 1992 (Federal Register notice 57FR14653). Monitoring strategies have been designed to document trends in abundance, productivity, spatial structure, and diversity, and relating those metrics to viability criteria (ICBTRT 2007). Viability is assessed at the population scale but must also be considered at a broader spatial scale. The long-term viability of Chinook Salmon on a broad scale such as an ESU is thought to be dependent on large-scale interactions among individual populations.

The Middle Fork Salmon River (MFSR) basin is an ideal area to study the persistence and spatial dynamics of Snake River spring-summer Chinook Salmon (hereafter Chinook Salmon) for several reasons. No hatchery releases have occurred in the MFSR, meaning Chinook Salmon stocks are wild and indigenous (IDFG 2019). Most of the basin is located within the Frank Church River of No Return Wilderness, which has limited anthropogenic habitat degradation (Thurow 2000). Finally, the MFSR basin consists of approximately 800 km of Chinook Salmon spawning habitat spread across the main stem and ten tributary basins which have consistently supported spawning in recent decades. Thus, the MFSR basin represents a large, complex network of relatively unaltered Chinook Salmon spawning habitat occupied by wild, indigenous stocks.

Intensive monitoring in the MFSR has been conducted since 1995 to better understand persistence and spatial dynamics of Chinook Salmon (Thurow 2017). This monitoring effort was designed to investigate the influence of habitat area, quality, and configuration on the distribution, pattern, and persistence of Chinook Salmon. In the late 1990s and early 2000s Chinook Salmon abundance in the MFSR increased and spawners expanded into previously unoccupied portions of the basin, but the majority of redds remained clustered in a limited area of the basin (Isaak and Thurow 2006).

The objective of this chapter is to summarize the 2021 surveys in the MFSR designed to describe factors influencing the spatial distribution and persistence of wild-origin Chinook Salmon. Survey methods and study sites were consistent with those first implemented by the Rocky Mountain Research Station in 1995. The specific objectives of this study are to: 1) monitor Chinook Salmon distribution and abundance by mapping the annual distribution of Chinook Salmon redds across the entire Middle Fork Salmon River basin, 2) assess spatial and temporal colonization dynamics of Chinook Salmon, 3) describe both individual and population level Chinook Salmon genetic variation, and 4) evaluate methods for measuring Chinook Salmon dispersal for describing salmon life history patterns. This work includes 260 km of Chinook Salmon spawning habitat beyond what is sampled for index surveys.

METHODS

Study Design

All tributaries that were known to historically support Chinook Salmon spawning were selected to be surveyed. Determination of historical and current occurrence was made by reviewing past redd surveys, anecdotal accounts of spawning activities, interviewing biologists familiar with the MFSR, and reviewing records of juvenile Chinook Salmon occurrence (Isaak and Thurow 2006). Three tributaries (Sheep Creek, Wilson Creek, and Little Loon Creek) that had previously been surveyed as part of basinwide redd counts in the MFSR, have not been surveyed since 2020. Zero redds have been observed in Sheep and Wilson creeks since basinwide redd counts began in 1995 (Thurow 2018). Little Loon Creek was added to basinwide redd counts in 2016, and zero redds have been observed in 2 years of surveys (Thurow 2017). We are unaware of any historical records of Chinook Salmon redds in Little Loon Creek. These three streams are assumed to not currently support Chinook Salmon spawning but will be surveyed when adult escapements above Lower Granite Dam exceed 30,000 natural-origin fish to monitor for recolonization. Surveys were targeted to occur between September 5-12, which coincides with the end of the spawning period while redds are still visible (Thurow 2010).

Data Collection

Surveys were conducted by flying, walking, or floating along designated stream sections and examining the streambed for redds. Aerial surveys were conducted from a helicopter between 0930 and 1800 hours to increase the likelihood of direct overhead sunlight (Copeland et al. 2019). Airspeeds ranged approximately 10-20 knots and surveys were suspended if the pilot was unable to maintain these airspeeds. Altitudes ranged 15-50 m above ground level. Two trained observers examined the streambed for redds. All redds were georeferenced using GPS. The primary observer, located in the front seat, marked locations using a Garmin Rino 750 handheld GPS unit, and the secondary observer, located in the back seat, marked locations using the same model of GPS as a backup. In 2021 flights occurred from September 8-13.

Raft surveys were conducted by USFS personnel on the main stem Middle Fork Salmon River from Boundary Creek to the confluence with the Salmon River every other week from early August until mid-September. No IDFG staff accompanied USFS personnel on the 2021 surveys because the final survey of the season was cancelled due to multiple large wildfires converging on the Middle Fork Salmon River mainstem. Two rafts floated the river in tandem, one on river right and one on river left. The bow of each raft was outfitted with an elevated observation platform, and the platform on each raft was occupied by a trained observer for the duration of the float. Whenever observers spotted likely spawning habitat they instructed the oarsman to approach it and float by as slowly as possible so it could be examined for redds. When a redd was spotted, the oarsman landed the raft at the nearest safe point. Once landed, the observer waded back to the redd and marked it using handheld GPS (Garmin Rino 750 or Garmin Rino 650). Signs and flagging were then installed to protect the redd from disturbance by other rafters. When side channels or other river morphology features made the raft survey method impractical both trained observers got off the rafts and walked those areas. The number of redds reported is the sum of new redds observed on each raft survey pass.

Ground surveys consisted of either multiple pass surveys or single pass surveys targeted to occur from September 5-12, which coincides with the end of the spawning period while redds are still visible (Thurow 2010). Multiple pass surveys were used for reaches where IDFG index counts occur during the peak of spawning and in populations that are intensively surveyed for fish-in, fish-out monitoring. For these reaches, additional passes were made after the peak count such that a final pass occurred at the end of the spawning period (Copeland et al. 2019). During ground and raft surveys, observers examined the streambed and marked redds using handheld GPS (Garmin Rino 750 or Garmin Rino 650). On each pass of multiple pass surveys, newly observed redds were flagged and assigned a unique number to avoid double counting. Flagging was removed on the final pass.

RESULTS

In 2021 a total of 362 Chinook Salmon redds were identified across 735.9 km of stream surveyed in the MFSR basin (Table 2-1, Figure 2-1). Aerial surveys encompassed 54% of the surveyed area. Multiple pass ground counts occurred in all IDFG index transects in the Bear Valley Creek and covered all potential spawning habitat upstream of the rotary screw trap in Marsh Creek. All other aerial, raft, and ground counts consisted of a single pass at the end of the spawning period.

Redds were observed for all surveyed streams within the Middle Fork Salmon River basin. Redd counts were highly variable among streams surveys ranging from a low of one observed in the Middle Fork Salmon River below Indian Creek to a high of 153 in Bear Valley Creek. The 2021 basinwide redd count was below the 1995-2019 average (Figure 2-2) each of the streams surveyed being below the 1995-2019 average. The majority of redds (71.3%) were in two high elevation populations (Bear Valley and Marsh creeks) at the upper extent of the MFSR drainage (Figure 2-3).

DISCUSSION

The number of redds counted in 2021 across the MFSR basin decreased from 2020 but remained above all-time lows. The number of redds counted was well below the 1995-2020 average of 735 redds. Spawner abundance, along with patch size and connectivity of spawning habitat, influence distribution of Chinook Salmon redds in the MFSR (Isaak and Thurow 2006; Isaak et al. 2007). When spawner abundance is low, most redds are found in areas with large patches of spawning habitat and high connectivity among those patches (Isaak and Thurow 2006). The distribution of redds in 2021 was consistent with this observation, as 71.3% of redds were found in the upper Middle Fork basin, where large connected patches of spawning habitat occur within Bear Valley Creek and Marsh Creek drainages.

The data collected in this study add another year to a rich data set which has been used in studies of temporal change in population synchrony (Isaak et al. 2003), sampling design for monitoring Chinook Salmon populations (Courbois et al. 2008), temporal variation in redd distribution (Isaak and Thurow 2006), factors affecting natal homing (Neville et al. 2006), genetic structure of Chinook Salmon (Neville et al. 2006), factors affecting use of spawning patches (Isaak et al. 2007), and effects of climate change and fire regime on redd distribution (Jacobs et al. 2021). Analysis of the spatial and temporal variability of Chinook Salmon in the MFSR basin will continue as this data set continues to grow.

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TABLES

Table 2-1. Stream length surveyed and Chinook Salmon total redd counts in the Middle Fork Salmon River, Idaho, 2021. See Abbreviations and Acronyms pages for population abbreviations.

Population	Length (km)	Redds
MFSRL	107.7	1
BIG[a]	120.6	47
CAM	74.8	14
LOON	85.8	22
MFSRU	172.8	14
SUL	23.5	6
BVC[b]	96.9	153
MAR	53.8	105
Total	**735.9**	**362**

[a] Staff from Nez Perce Tribe, U.S. Forest Service, and Idaho Department of Fish and Game collected and provided information.

[b] Staff from the Shoshone-Bannock Tribes, U.S. Forest Service, and Idaho Department of Fish and Game collected and provided information.

FIGURES

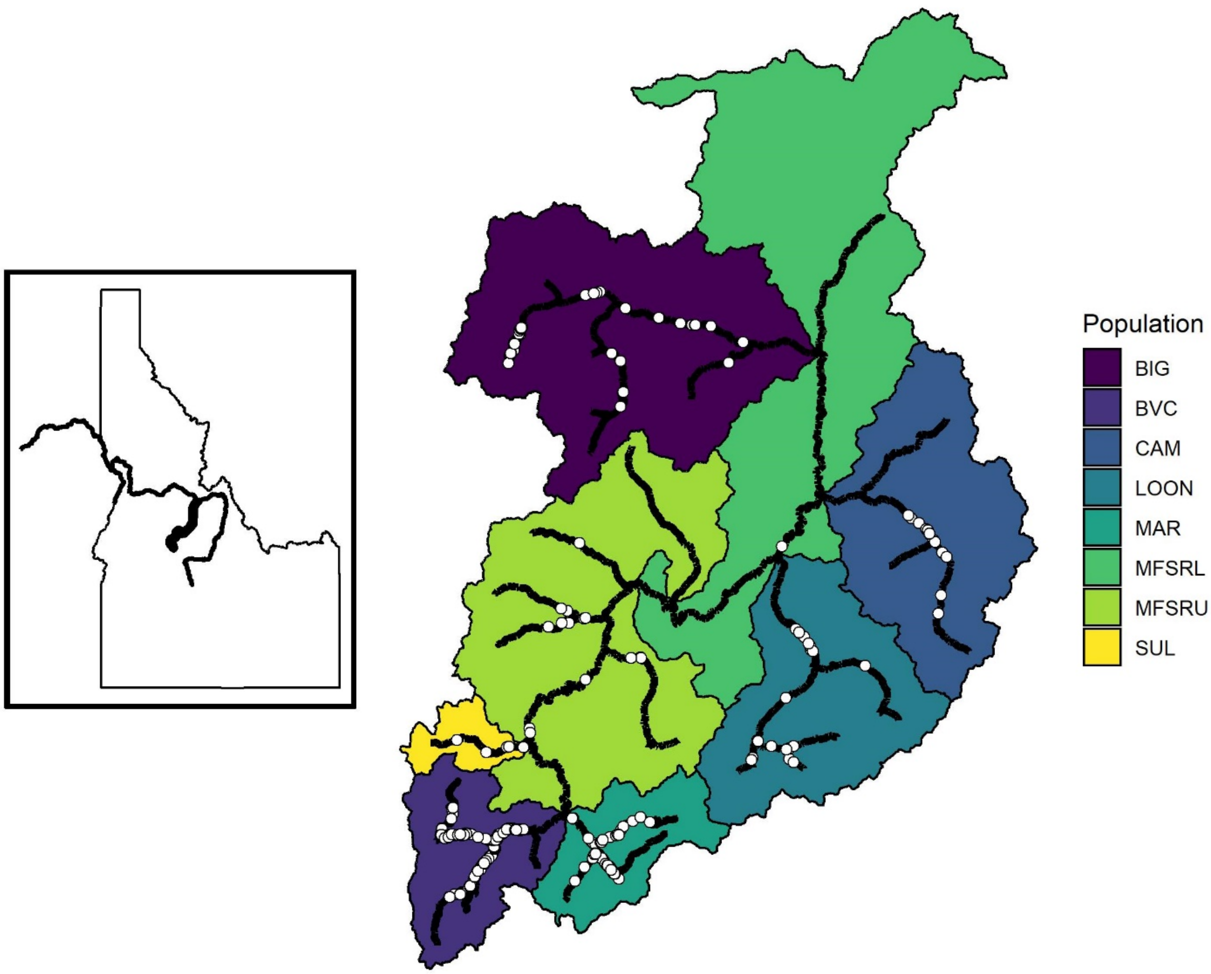

Figure 2-1. Chinook Salmon redds (white circles; N = 362) observed in independent populations of the Middle Fork Salmon River basin, Idaho, 2021. Bold line indicates main stem Middle Fork Salmon River.

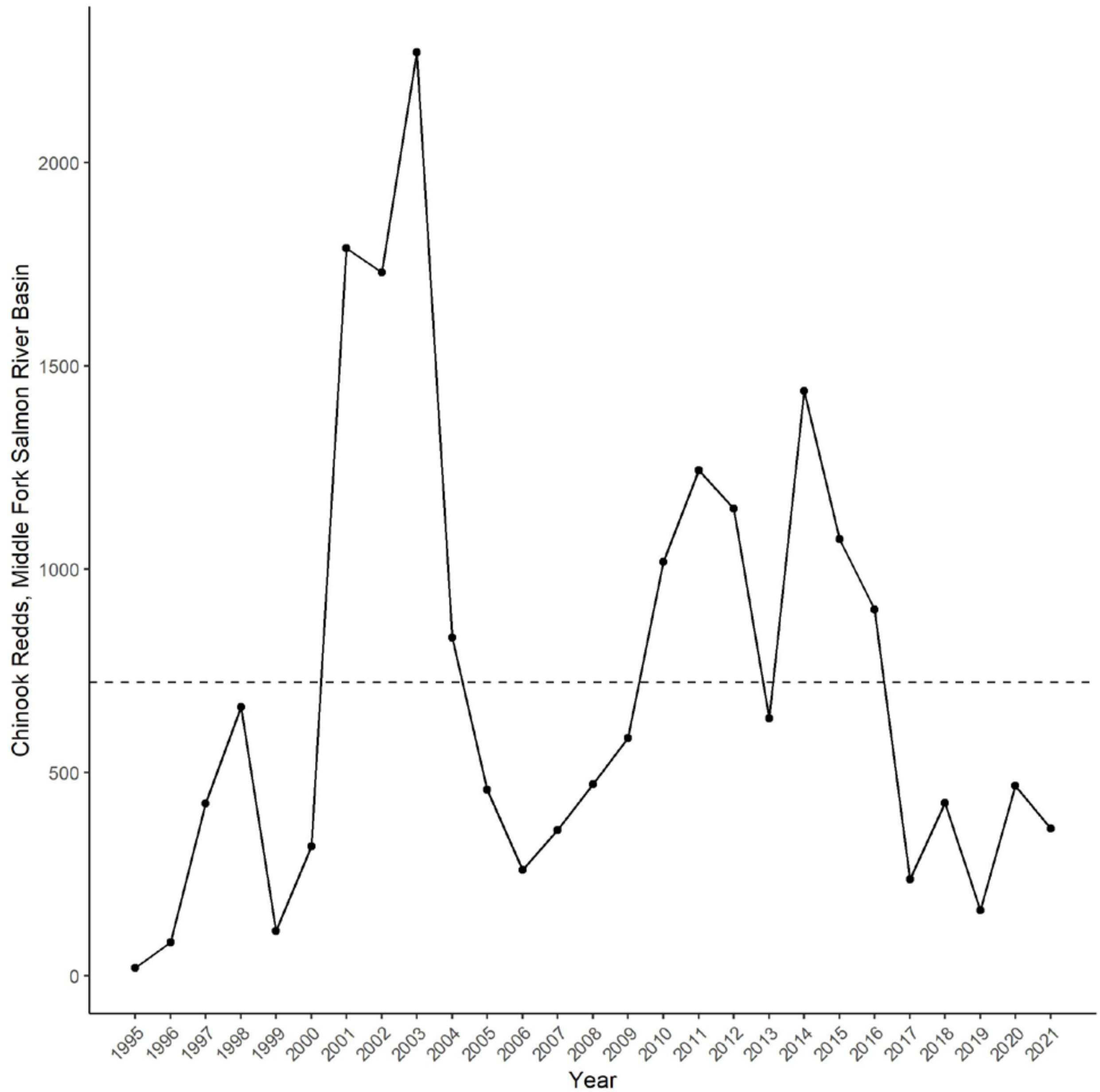

Figure 2-2. Total redd counts in the Middle Fork Salmon River basin, Idaho, 1995-2021. Dashed line represents the average redd abundance for 1995-2020.

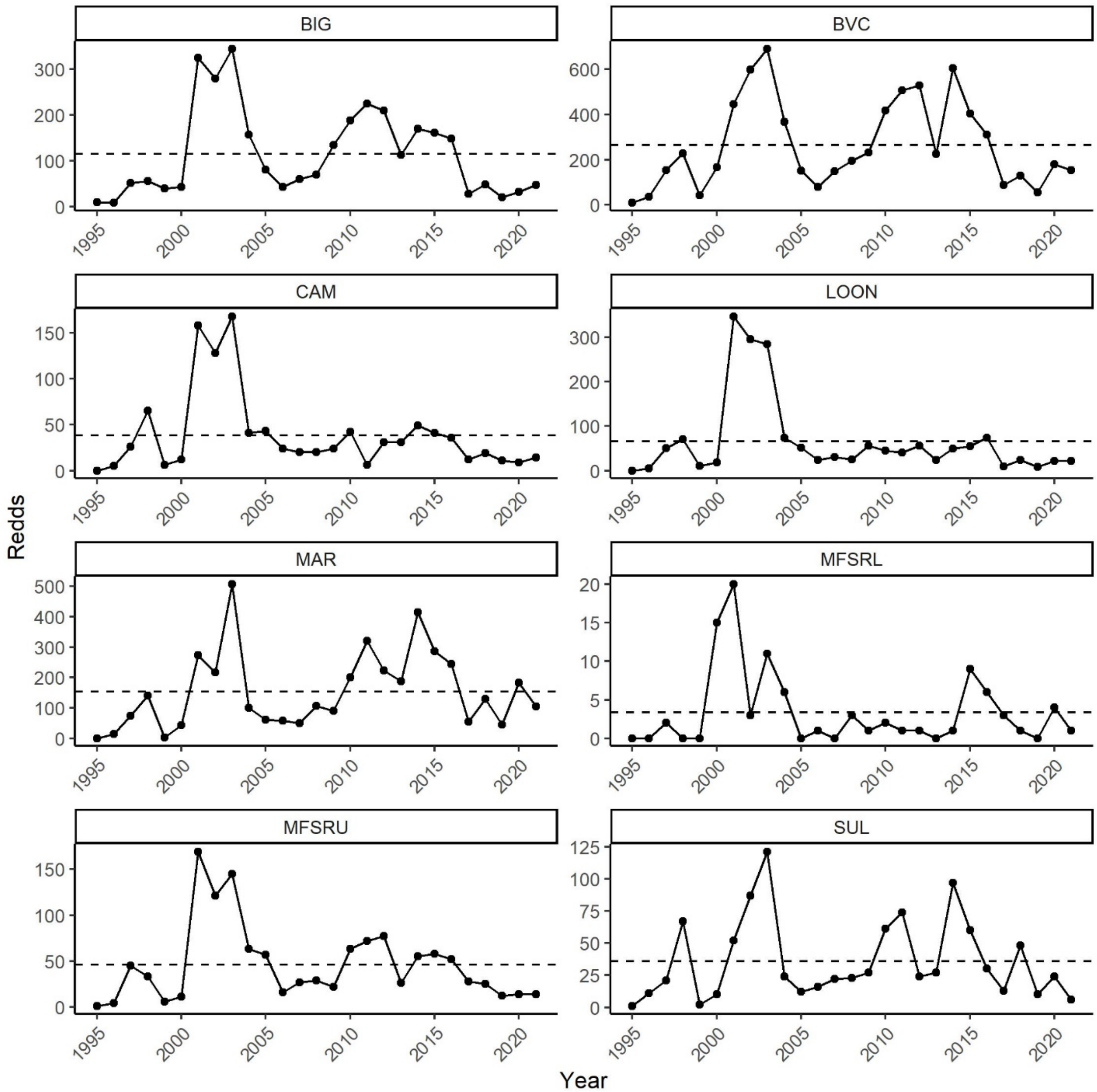

Figure 2-3. Total redd counts in independent populations of the Middle Fork Salmon River basin, Idaho, 1995-2021. Dashed line represents the average for 1995-2021. Note differing scales on y-axes.

APPENDICES

Appendix A. Additional information collected on spawning ground surveys and at hatchery weirs in 2021.

Joshua R. Poole, Fisheries Biologist

INTRODUCTION

Chinook Salmon spawning ground surveys are primarily designed to monitor status and trends in abundance and productivity within and among Idaho populations. However, some additional data are collected in order to monitor more intensively at smaller scales and to address ancillary objectives. These data are not comparable on the broad scale that is the main focus of this report. In most cases, these data will eventually be used in completion reports on projects such as habitat effectiveness monitoring and genetic diversity monitoring, or help to improve monitoring methods. The purpose of this appendix is to report the annual collection methods for these data.

METHODS

Multiple Pass Surveys

Multiple pass redd counts were used to estimate total redds within two populations, Marsh Creek and Lemhi River, and in the Salmon River upper mainstem from Redfish Lake Creek to Sawtooth weir. Multiple pass surveys were designed to begin with the start of spawning activity, with subsequent surveys conducted weekly until the end of spawning activity (Copeland et al. 2019). Each survey followed data collection methods described in Chapter 2 of this report. On each pass, newly observed redds were flagged, assigned a unique number, and georeferenced using GPS units. Flags were removed on the last pass. In prior years, additional redd surveys were completed in various streams in the Clearwater River basin, however, no additional redd counts beyond the index counts reported in Chapter 2 were conducted in 2021. Multiple pass redd survey data was downloaded from the SGS database on 19 January 2022.

Weir Passage

Adult Chinook Salmon passage is recorded at IDFG weirs at the Pahsimeroi, Sawtooth, and South Fork Salmon River hatcheries. All fish released above weirs were marked with an opercle punch. Carcass surveys were conducted above weirs. Abundance above the Sawtooth and South Fork Salmon river weirs was estimated using the Chapman modification of the Lincoln-Petersen method (Chapman 1951, Seber 1982):

$$\widehat{N} = \frac{(M+1)(C+1)}{(R+1)} - 1,$$

where M was the number of fish marked at the weir, C was the number of carcasses recovered above the weir, and R was the number of marked carcasses recovered above the weir. Prespawn mortality was assessed by examining the spawning stage of carcasses collected on spawning grounds, and escapement was estimated by directly subtracting observed prespawn mortalities from estimated abundance.

Genetics Samples at Weirs and Traps

All adult Chinook Salmon captured at IDFG weirs or traps had the following data recorded: origin (natural or hatchery), any marks or tags, fork length (mm), and sex. We refer the reader to hatchery reports and to the Fish Inventory System Hatchery Database (FINS; http://www.fishnet.org/) to obtain more specific information. Tissue samples for genetics analysis were collected from all fish released upstream of the weir for natural spawning. Tissue samples were stored on Whatman sheets and delivered to the IDFG Eagle Fish Genetics Laboratory located in Eagle, Idaho.

RESULTS

Multiple Pass Surveys

Surveys in the Marsh Creek population went from the first week of August until the second week of September and documented 100 redds (Appendix Table A-1). Surveys in the Lemhi River population went from the third week of August until the third week of September and documented 64 redds (Appendix Table A-1). Valley Creek was also surveyed three times from the last week of August to the third week of September, 49 redds were observed (Appendix Table A-1). Surveys in the upper mainstem Salmon River went from the last week of August until the third week of September and documented 130 redds.

Weir Passage

A total of 105 Chinook Salmon were marked and passed above the Pahsimeroi weir, all of which were natural-origin (Appendix Table A-2). At the Sawtooth weir, 252 Chinook Salmon were marked and passed, 221 of which were of natural-origin. At the South Fork Salmon weir, a total of 353 Chinook Salmon were marked and passed, 110 of which were natural-origin. Above the Pahsimeroi weir, researchers did not examine carcasses for opercle punches, thus weir efficiency is unknown, but assumed to be 1.00. The South Fork Salmon River weir efficiency was found to be 1.00 for both hatchery- and natural-origin fish. The Sawtooth weir had an efficiency value 0.83 for natural-origin individuals, resulting in an abundance estimate of 262; the efficiency for hatchery-origin was 0.93, resulting in an abundance estimate of 33 individuals.

Genetic Samples at Weirs and Traps

A total of 732 tissue samples were collected from Chinook Salmon released at IDFG hatchery and research weirs during 2021 (Appendix Table A-3). Most samples (n = 338) were collected from the South Fork Salmon River. Genetic samples from the South Fork Salmon River, the Pahsimeroi River and reaches of the Salmon River near the Sawtooth weir are used to evaluate performance of the Integrated Broodstock Program in those rivers (e.g., Venditti et al. 2020). The East Fork Salmon River weir was not operated for Chinook Salmon in 2021 and no samples were collected. Chinook Salmon are incidental catch at the Fish Creek research weir, which is operated for steelhead *Oncorhynchus mykiss*.

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Appendix Table A-1. Multiple-pass redd count census surveys that were conducted for Chinook Salmon in Idaho during 2021. Surveys are organized by major population group (MPG).

Population	Waterbody	Date	New redds	Date	New redds	Date	New redds	Date	New redds	Date	New redds	Date	New Redds	Total
						Middle Fork Salmon River MPG								
Marsh Creek	Beaver Creek	8/8	3	8/13	4	8/20	6	8/27	2	9/2	0	9/10	0	15
	Banner Creek	8/6	0	8/15	1	8/23	0	8/29	0	9/5	0	9/12	0	1
	Cape Horn Creek	8/6	2	8/15	2	8/23	3	8/29	1	9/5	0	9/12	0	8
	Knapp Creek			8/16	0	8/22	0	8/28	0	9/6	0			0
	Marsh Creek	8/7	10	8/14	14	8/22	31	8/28	15	9/4	6	9/11	0	76
Total New Redds			15		21		40		18		6		0	100
						Upper Salmon River MPG								
Lemhi River	Bear Valley Creek	-	-	8/18	0	8/24	0	-	-	-	-	-	-	0
	Big Springs Creek	-	-	-	-	8/27	0	-	-	-	-	-	-	0
	Big Timber Creek	-	-	-	-	8/24	0	-	-	-	-	-	-	0
	Hayden Creek	-	-	8/18-8/20	0	8/24-8/26	1	9/1	20	9/9	3	9/23	0	24
	Lemhi River	-	-	-	-	-	-	-	-	9/8	19	9/22	21	40
	Little Springs Creek	-	-	-	-	8/23	0	8/30	0	-	-	-	-	0
Total New Redds					0		1		20		22		21	64
Valley Creek	Valley Creek	-	-	-	-	8/29	25	8/30	4	9/9	14	9/16	6	49
Total New Redds							25		4		14		6	49
Salmon River Upper Mainstem Above Redfish Lake	Redfish Lake Creek upstream to Sawtooth Weir	-	-	-	-	9/1	72	9/8	41	9/15	15	9/21	2	130
Total New Redds							72		41		15		2	130

Appendix Table A-2. Data collected for estimating Chinook Salmon abundance above IDFG weirs in 2021. M = Number of fish marked and passed above weirs, C = number of carcasses recovered above weirs, R = number of carcasses marked and recovered above weirs, and N = estimated abundance.

	Natural-origin						Hatchery-origin					
Weir	**M**	**C**	**R**	**Prespawn mortalities**	**Weir efficiency**	**N**	**M**	**C**	**R**	**Prespawn mortalities**	**Weir efficiency**	**N**
Pahsimeroi[(a)]	105	6	0	0	1.00	105	0	0	0	0	1.00	0
Sawtooth	221	124	103	2	0.83	262	31	15	14	0	0.93	33
South Fork Salmon	110	16	16	0	1.00	110	243	9	9	0	1.00	243

[a] Recovered carcasses were not checked for opercle punches; weir efficiency is assumed.

Appendix Table A-3. Number of genetic samples collected from Chinook salmon released upstream of IDFG hatchery and research weirs, 2016-2021.

Weir	2016	2017	2018	2019	2020	2021
Salmon River (Sawtooth)	421	305	152	78	191	251
Pahsimeroi River	399	277	320	92	161	105
South Fork Salmon River	709	389	455	291	110	338
Rapid River	23	30	30	19	22	27
Hells Canyon Dam	29	0	3	1	17	11
Lochsa River (Powell)	23	24	27	0	0	0
Fish Creek	3	3	0	0	1	0
Red River	31	22	15	0	0	0
Crooked River	30	8	13	0	0	0
Total	1,668	1,058	1,015	462	502	721

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